

# **GEOPAK Drainage V8i Course Manual**



**Tennessee Department of Transportation  
Roadway Design Division**

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The information in this manual is based on the following software versions:

MicroStation V8i - SELECT Series 2 Edition (08.11.07.443)

GEOPAK V8i – SELECT Series 2 Edition (08.11.07.615).

## Resources

Tennessee Department of Transportation Drainage Manual:

[http://www.tdot.state.tn.us/Chief\\_Engineer/assistant\\_engineer\\_design/design/DrainManChap%201-11.htm](http://www.tdot.state.tn.us/Chief_Engineer/assistant_engineer_design/design/DrainManChap%201-11.htm)

Tennessee Department of Transportation Design Guidelines and Instructional Bulletins:

[http://www.tdot.state.tn.us/Chief\\_Engineer/assistant\\_engineer\\_design/design/DesGuide.htm](http://www.tdot.state.tn.us/Chief_Engineer/assistant_engineer_design/design/DesGuide.htm)

Tennessee Department of Transportation Design V8 CADD Standards and Downloads:

[http://www.tdot.state.tn.us/Chief\\_Engineer/assistant\\_engineer\\_design/design/v8/V8design.htm](http://www.tdot.state.tn.us/Chief_Engineer/assistant_engineer_design/design/v8/V8design.htm)

Tennessee Department of Transportation Standard Drawings Library:

[http://www.tdot.state.tn.us/Chief\\_Engineer/engr\\_library/stdlib.htm](http://www.tdot.state.tn.us/Chief_Engineer/engr_library/stdlib.htm)

Federal Highway Administration Hydraulic Engineering Circular NO. 22, Second Edition  
Urban Drainage Design Manual:

<http://isddc.dot.gov/OLPFiles/FHWA/010593.pdf>

# **GEOPAK Drainage V8*i***

## **Course Manual**

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# Getting Started

This exercise introduces the GEOPAK Drainage workflow to complete the setup required for a new project. The user will review the project information and set the preferences.

GEOPAK Drainage gives you the best design and analysis based on the input that you enter. Engineering judgment must be used to evaluate the output that the program produces. Refer to the TDOT Roadway Design Division Drainage Manual for additional guidance.

## 1.1 Project Workflow

The GEOPAK Drainage workflow mirrors a conventional design process beginning with the design of the surface collection system (inlets, drainage areas) followed by the design of the conveyance system (subsurface pipes, channels).

Roadway alignments, vertical profiles, and digital terrain models may be used throughout GEOPAK Drainage to provide pertinent information to the drainage design. All drainage components feature interactive *graphical placement tools* for easy definition of the drainage system.

Each of these components (inlets, areas, and pipes) is composed of two basic types of information:

- Spatial information describing its location, shape and connectivity.
- Hydraulic and Hydrologic information describing its properties, conventions and other associated attributes.

## 1.2 Drainage Components

GEOPAK Drainage organizes the components of a drainage system according to their spatial characteristics. Spatial information is stored as **Nodes**, **Links** and **Networks**. This information is stored in a \*.gdf file – GEOPAK Drainage File.

**Nodes:** A node (inlets, manholes, etc.) is a point with a user-defined location. The location may be in Cartesian coordinates (x,y) or in curvilinear coordinates (station, offset).

**Links:** A Link represents a linear feature depicting a path connecting two nodes, traversing upstream to downstream. The path may be straight line or curvilinear (along a graphic element).

**Networks:** A network is a system of interconnected nodes and links that form a system through which water can flow to a single outlet node. A drainage project accommodates any number of Networks.

Other associated components in GEOPAK Drainage include:

**Areas:** A drainage area can be represented by a closed boundary or simply keyed-in (acres or hectares). All flows from a single drainage area are tributary to a single Node. There is a one to one correspondence between a node and an area. Therefore areas and nodes share the same name (ID). A drainage area may contain multiple subareas representing homogeneous features such as soil types and land uses ("C" values), thereby allowing composite "C" value calculations.

**Profiles:** A profile represents a linear feature depicting a path connecting two nodes, it is different than a link in that a path may span multiple links and traverse upstream, downstream, or any combinations. The primary purpose of a profile is to allow visualization of a profile view between any two nodes in a drainage network.

## 1.3 Directory Information

Class files are located in the directory `c:\Projects\Drainage\*.*`

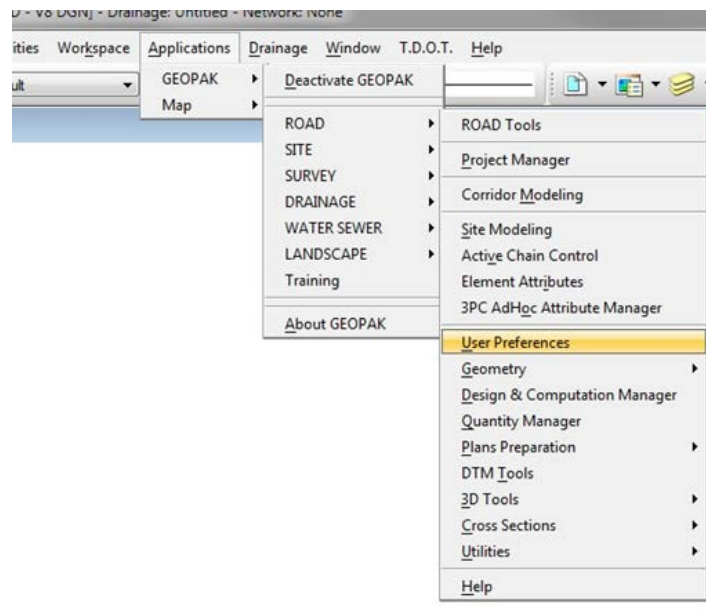
## 1.4 Set Main GEOPAK User Preferences

**Step 1.** Copy the Geopak Drainage project template file, DrainageProject.gdf from standard directory: C:\Users\Public\Geopak Standards to class project directory: **C:\Projects\Drainage\**

**NOTE:** For your project, the 'copy to' location would be your project folder.

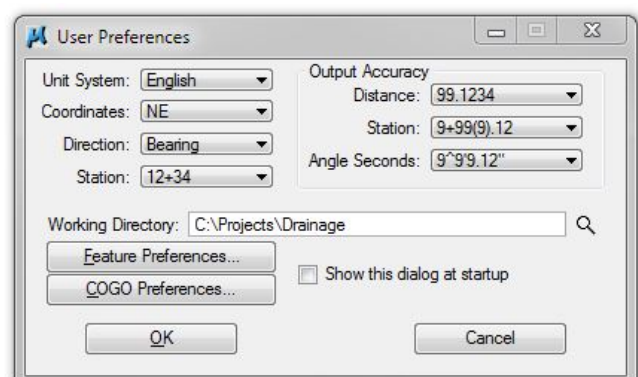
**Step 2.** Utilizing MicroStation, open DVSR1proposed.dgn

**Step 3.** The GEOPAK User Preferences control the output format of data produced using GEOPAK. Access the **User Preferences** by selecting **Applications > GEOPAK > Road > User Preferences**.



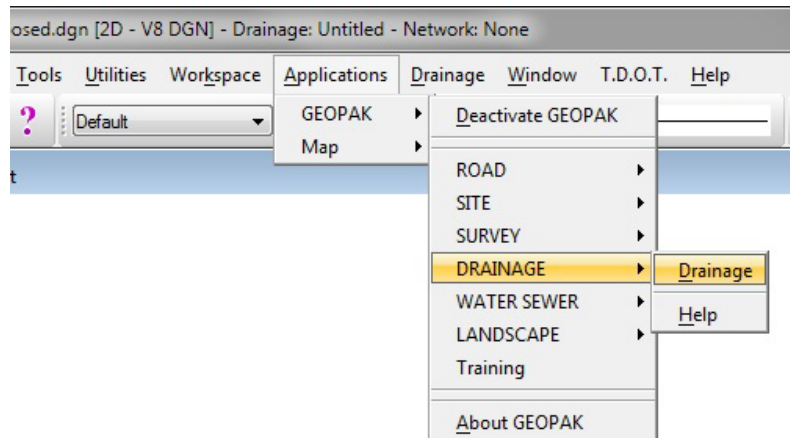
**Step 4.** Set the Units to **English**, Stationing to **12+34**, and Working Directory to **C:\Projects\Drainage\** and click **OK**.

**NOTE:** For your project, this would be your working directory.

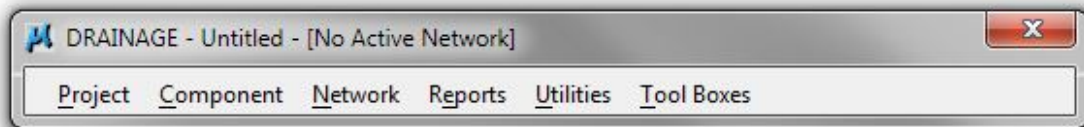


## 1.5 Invoke GEOPAK Drainage

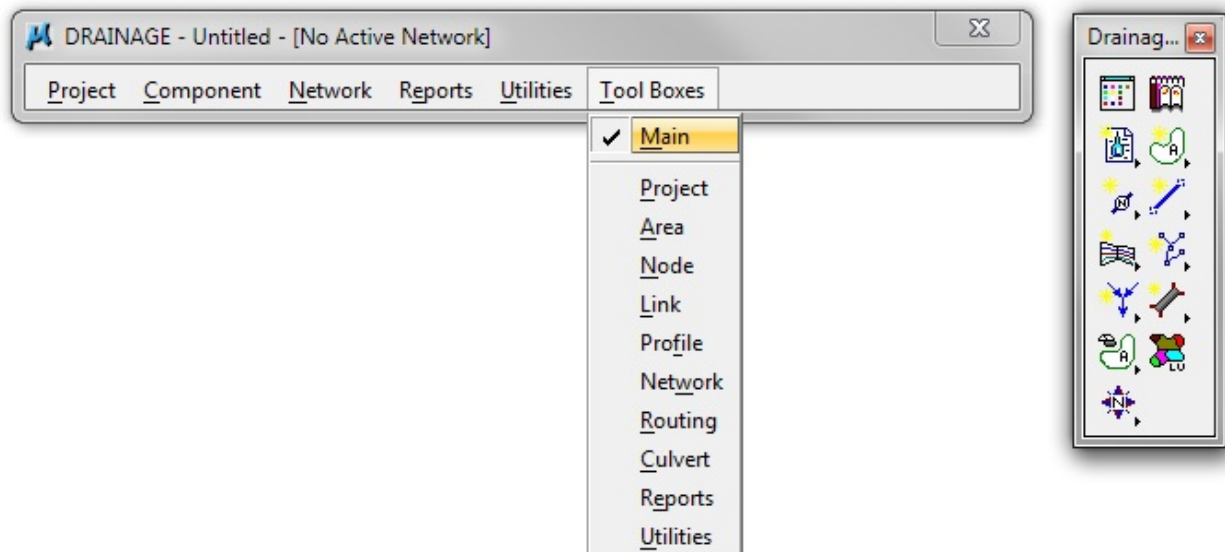
**Step 1.** Access GEOPAK Drainage from MicroStation's **Applications** menu:



All items in Drainage can be accessed through this main GEOPAK DRAINAGE Menu Bar:

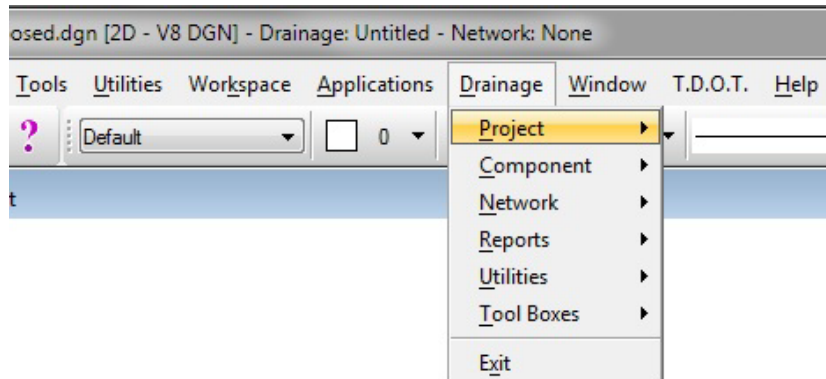


Or by invoking the GEOPAK Drainage **Main Tool Box** from **Tool Boxes>Main**:

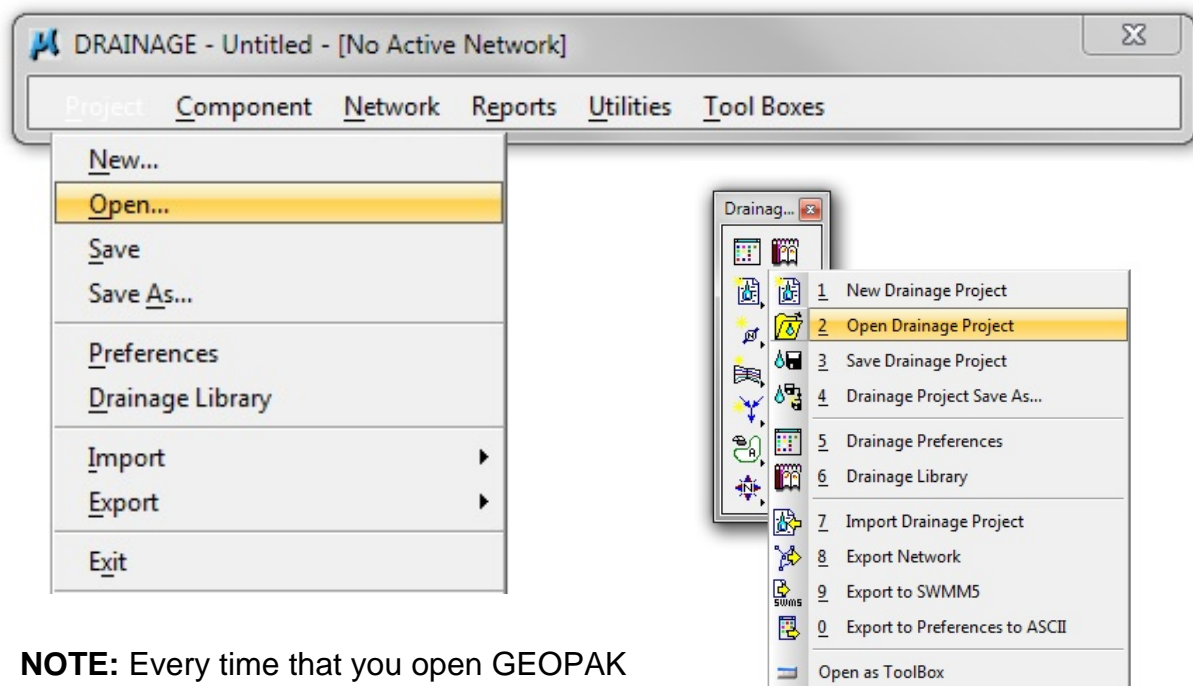


# Exercise 1

Or they can be accessed through the Drainage Menu which has been added to the main menu bar once you load GEOPAK Drainage.



**Step 2.** Open Geopak drainage project file **DrainageProject.gdf** that was copied

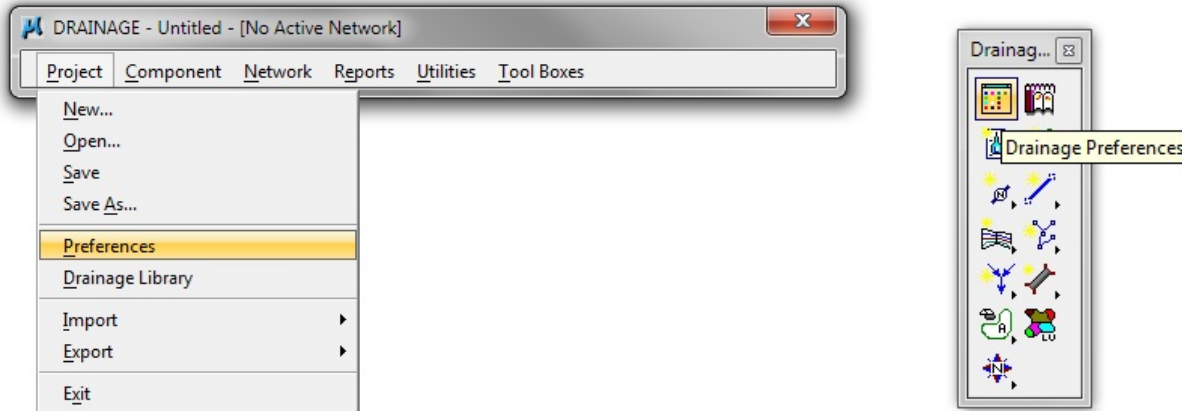


**NOTE:** Every time that you open GEOPAK Drainage, an untitled project will open. Therefore, you must go to **Project>Open** and select your project .gdf file every time you want to edit or continue working on a project.

## 1.6 Project Preferences

The Project Preferences control the *graphic and computational* options of the drainage system. The Project Preferences may be changed at any time and the system can then be redesigned or analyzed utilizing the new preferences.

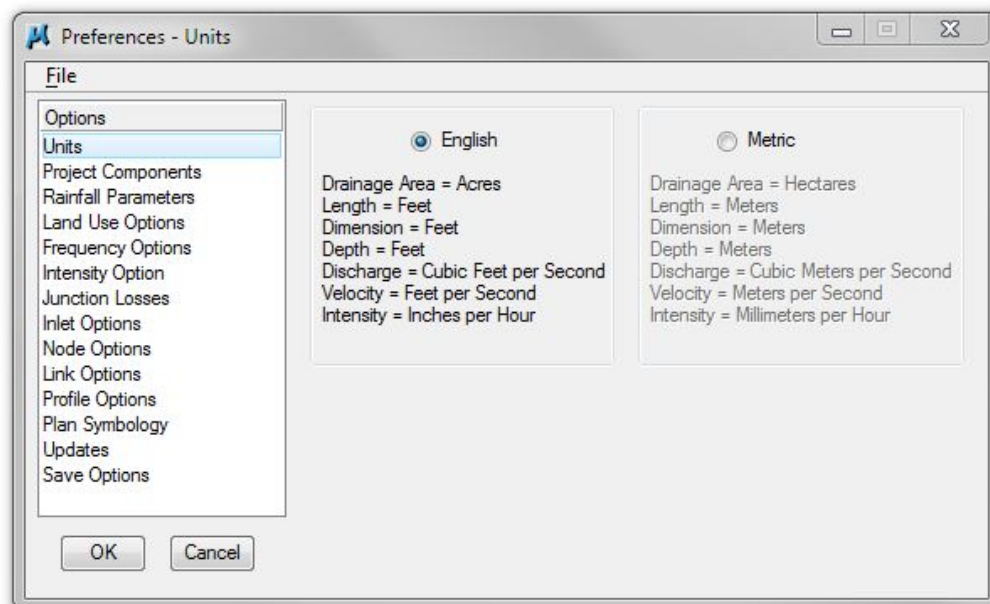
**Step 1. Select Project > Preferences.**



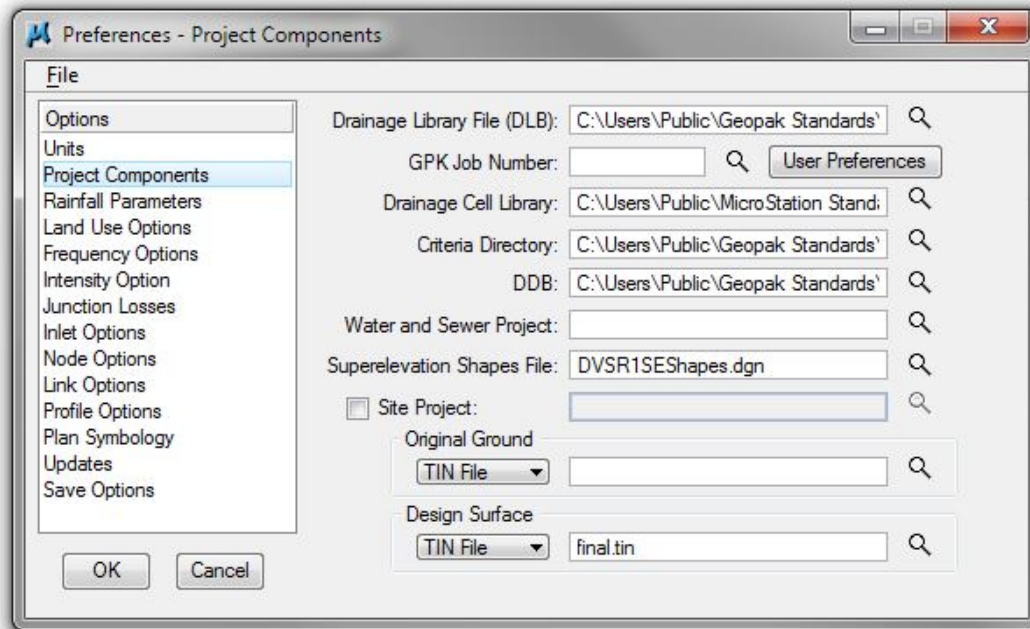
**NOTE:** Each Drainage Project should begin by copying the file in Step 1 of 1.4 into the project folder. This step automatically imports all needed preferences. If this step is missed, TDOT Standard Preferences may be loaded **after opening** the Preferences window and going to **File > Open** and navigating to the following file: **C:\Users\Public\Geopak Standards\TDOTdrainageprefs.dpf**

Review the Preferences by selecting each option in the column and reviewing the various options.

**Step 2. Units:**



## Step 3. Project Components:



**The following items are set to the defaults and NO CHANGES need to be made:**

**Drainage Library File (DLB)** – C:\Users\Public\Geopak Standards\TDOTEnglish.dlb

**User Preferences** – These settings are already set for you for this exercise.

**Drainage Cell Library** - C:\Users\Public\MicroStation Standards\cell\STDS.CEL

**Criteria Directory** - C:\Users\Public\Geopak Standards\Criteria

**GEOPAK DDB:** C:\Users\Public\Geopak Standards\tdot.ddb

**For each Library and Directory file location, select the explorer button and go to the following file locations:**

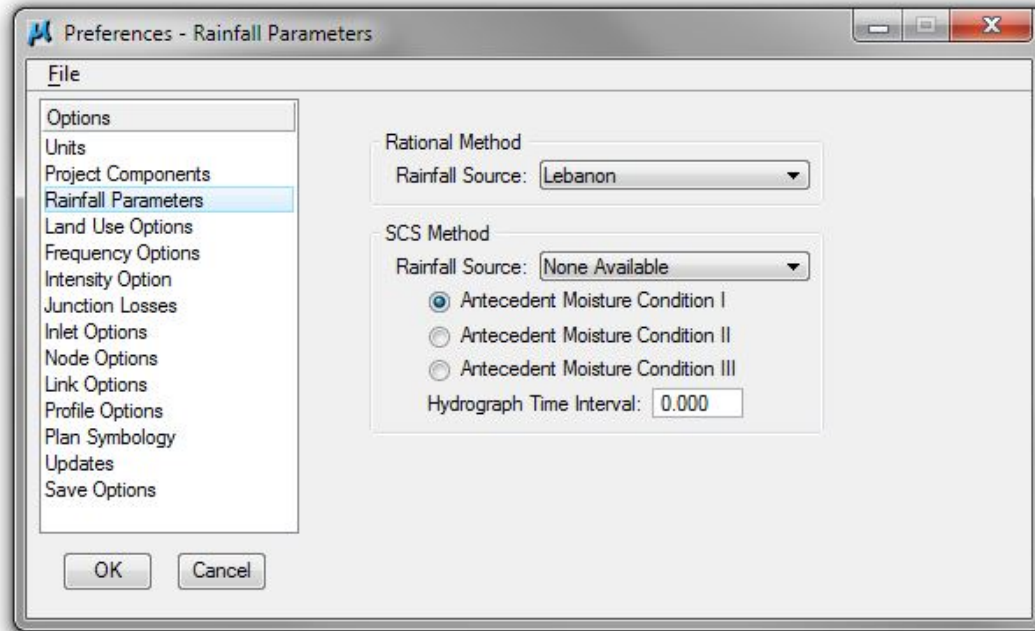
**GPK Job Number** – Pick the GPK file and it will automatically set the correct number (this only happens if it goes to the correct User Preferences)

**Superelevation Shapes File** – Choose DVSR1SEShapes.dgn from the project directory

**Design Surface** – Choose final.tin from the project directory. This final tin is a combination of the proposed tin and existing tin. The final tin includes the proposed areas inside the slopes and the existing area outside the slopes. The tin file has been created for your use in class. Refer to the [Geopak Road Course Guide](#) Chapter 22 for instruction on how to create a final tin file for your project.



#### Step 4. Rainfall Parameters:

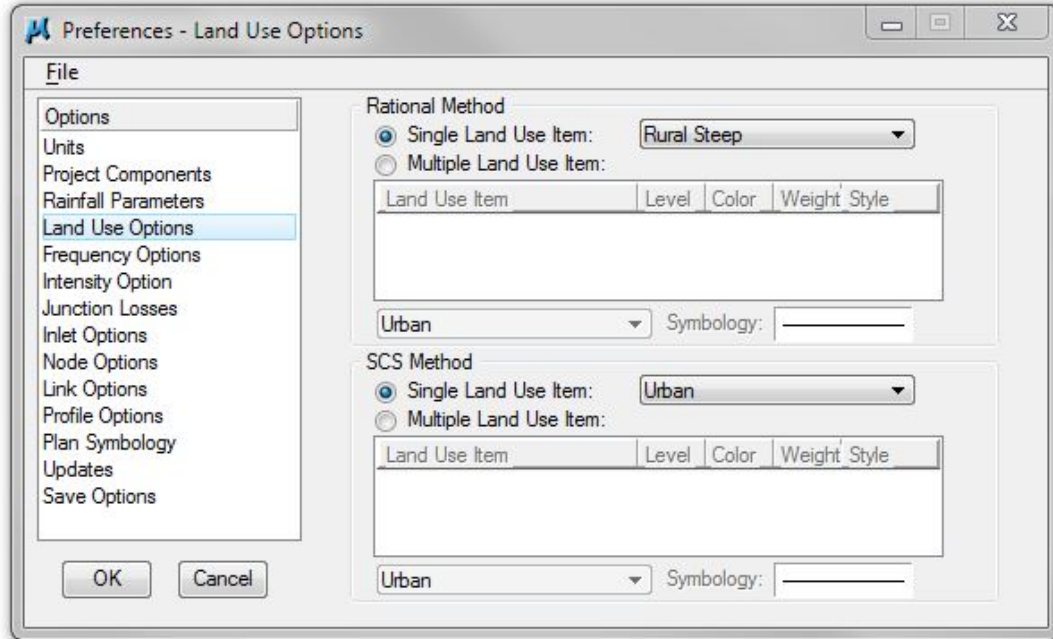


Select the appropriate rainfall source for the city closest to the project site.

See the [TDOT Drainage Manual](#), Chapter 4, Figure 4A-1.

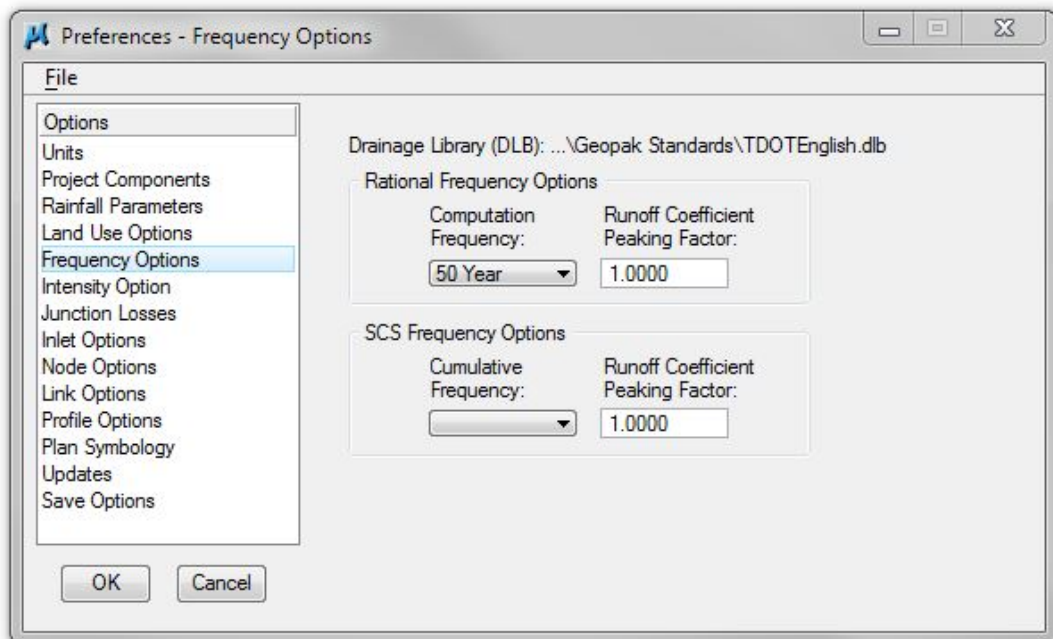
**NOTE:** The Tennessee Department of Transportation Roadway Design Division uses the Rational Method for drainage design.

## Step 5. Land Use Options:

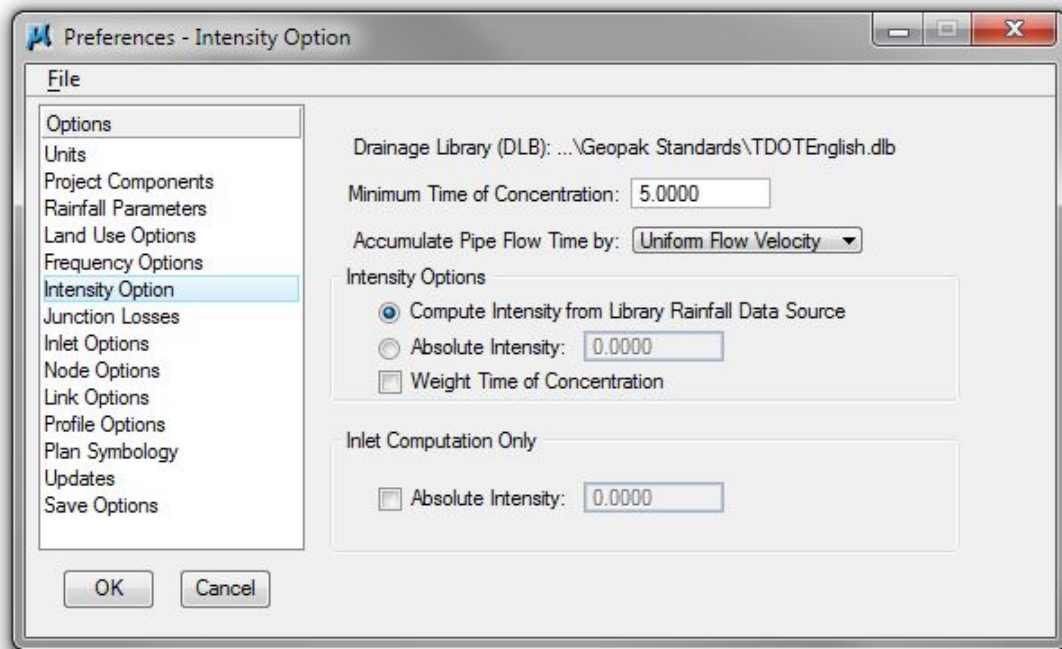


Set the Land Use Option to **Single Land Use Item: Rural Steep** for this class. The Roadway Design Division **does not** use the option for Multiple Land Use Items. All definitions for land use must come from a specific category.

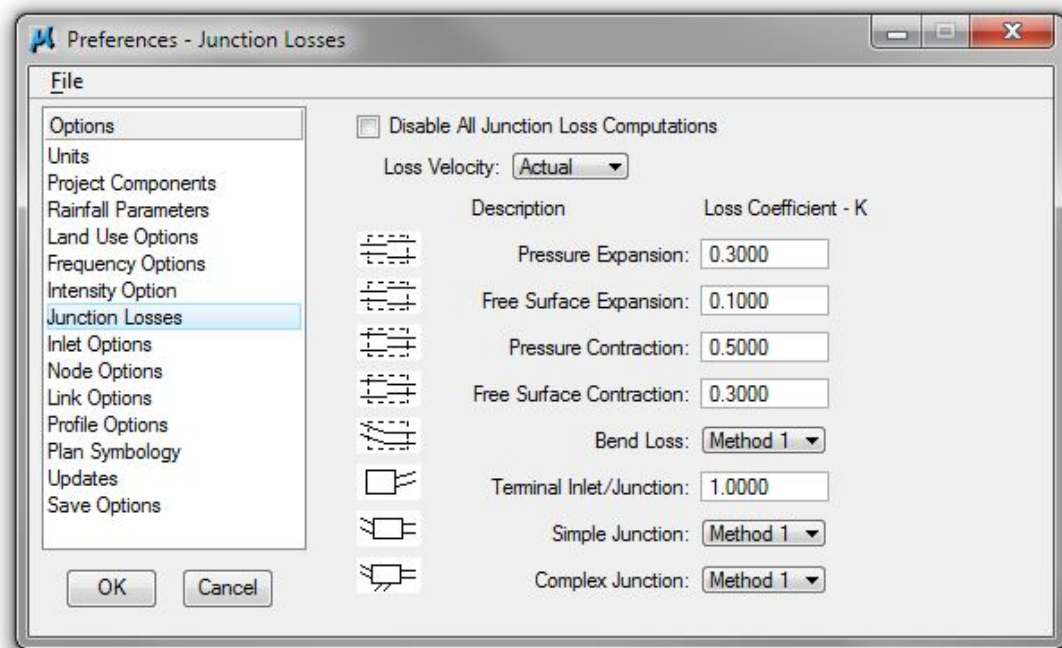
## Step 6. Frequency Options:



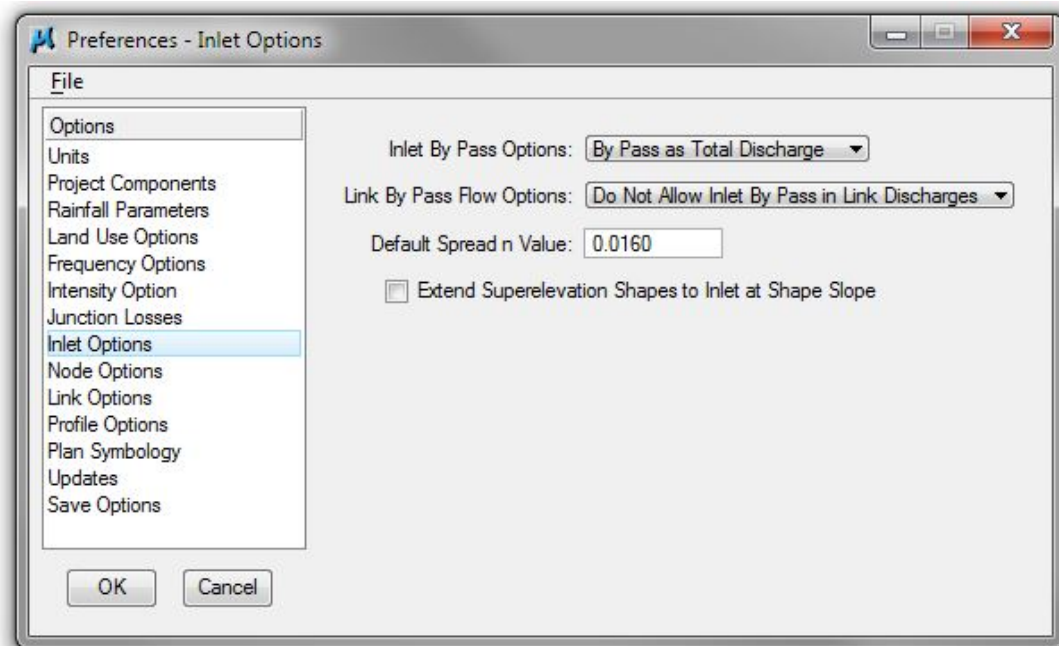
## Step 7. Intensity Options:



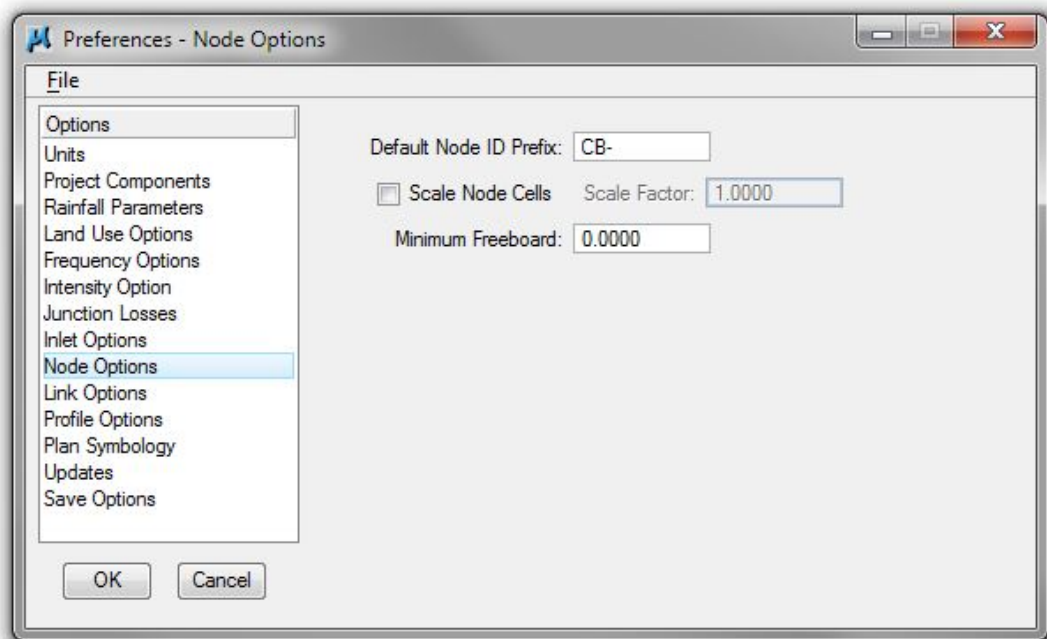
## Step 8. Junction Losses Options:



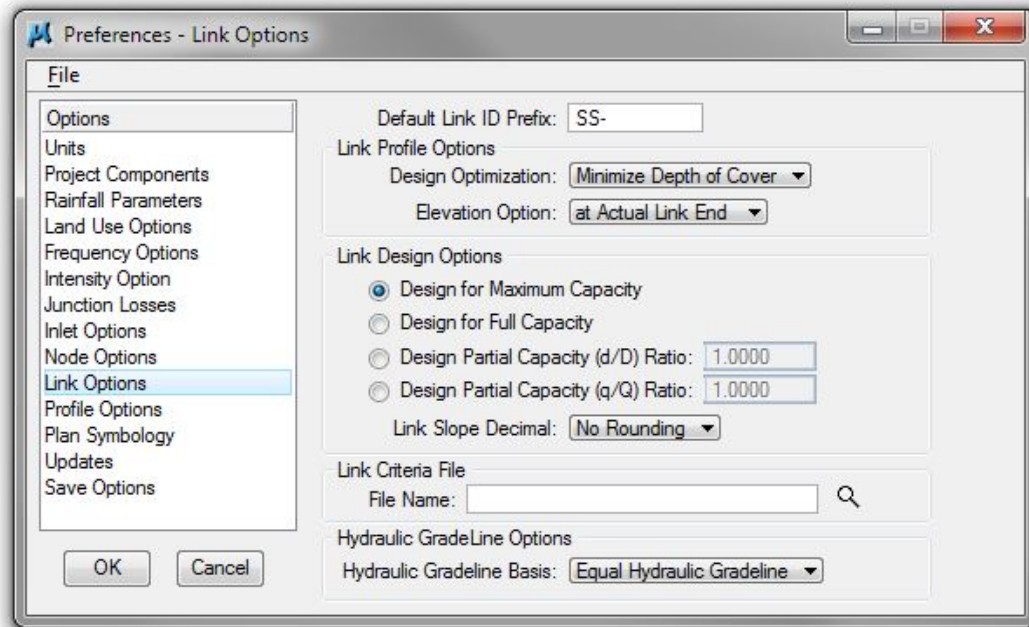
## Step 9. Inlet Options:



## Step 10. Node Options:



### Step 11. Link Options:



**NOTE:** Do **not** set the **Link Slope Decimal** to rounding. This setting is for control of Pipe Design not annotation. If set it will be impossible to design for minimum depth drainage structures.

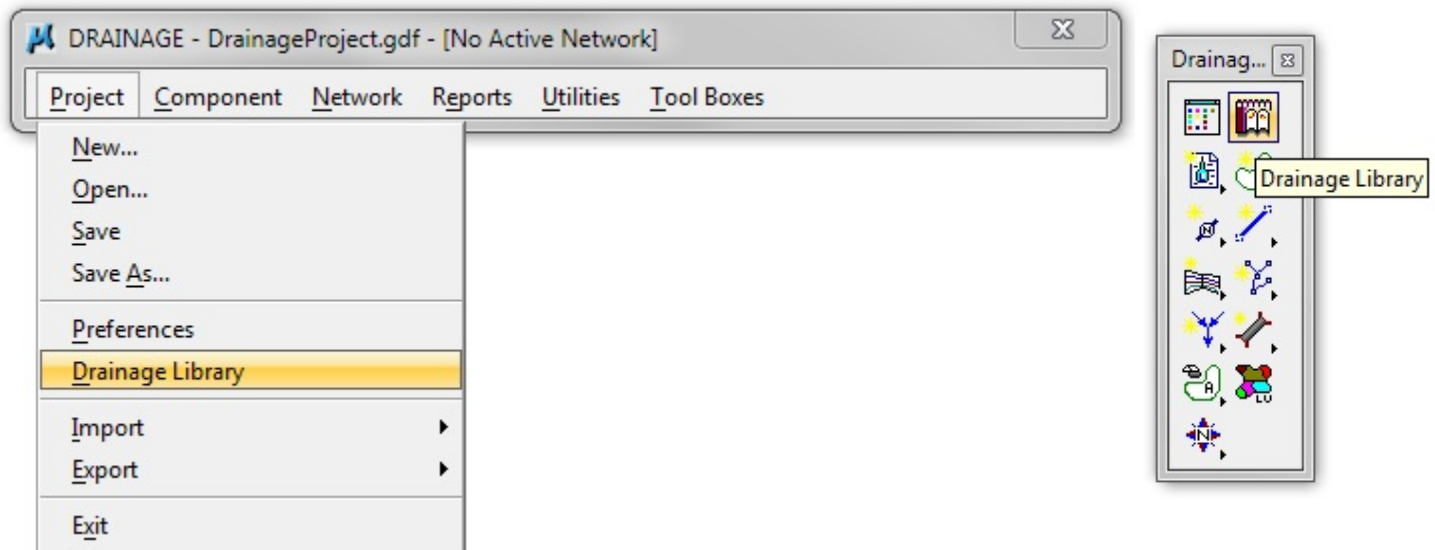
**Step 12.** Profile Options, Plan Symbology, Updates and Save Options should be kept at the default settings. Do not make any changes.

**Step 13.** Click **OK** to save changes and dismiss the dialog.

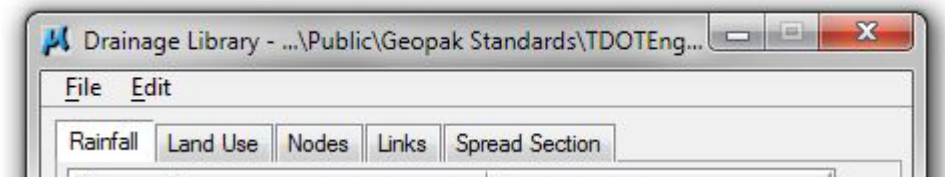
## 1.7 Review Drainage Library

The Drainage Library is used to store hydraulic, hydrologic, and construction standards, which may be shared by different projects and designers. Each GEOPAK Drainage project accesses items from the *Drainage Library* for use on the specific project.

**Step 1.** Select **Project > Drainage Library**. The library stored in the Preferences will be opened by default.



The Drainage Library currently contains five (5) tabs as shown below:

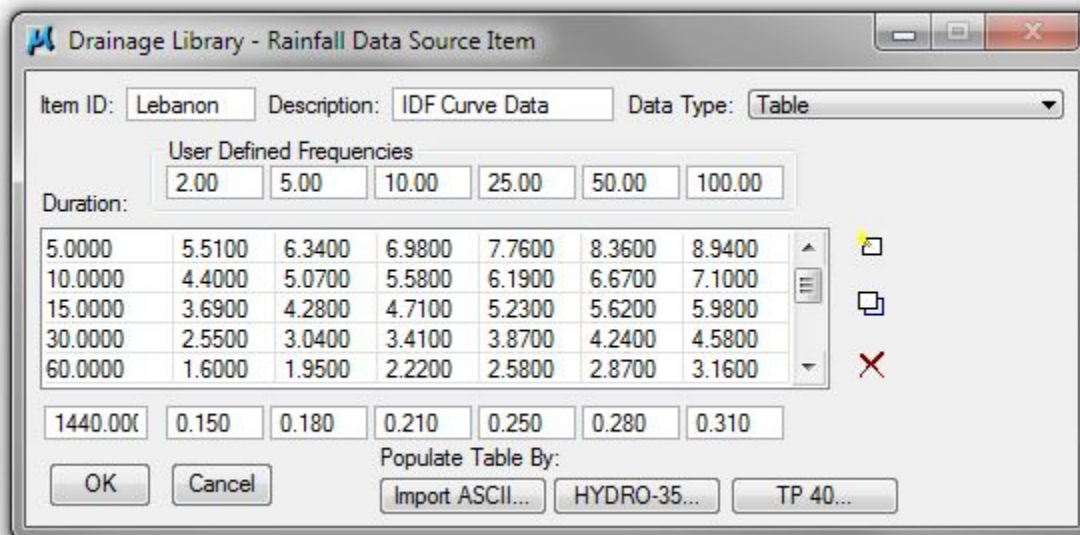
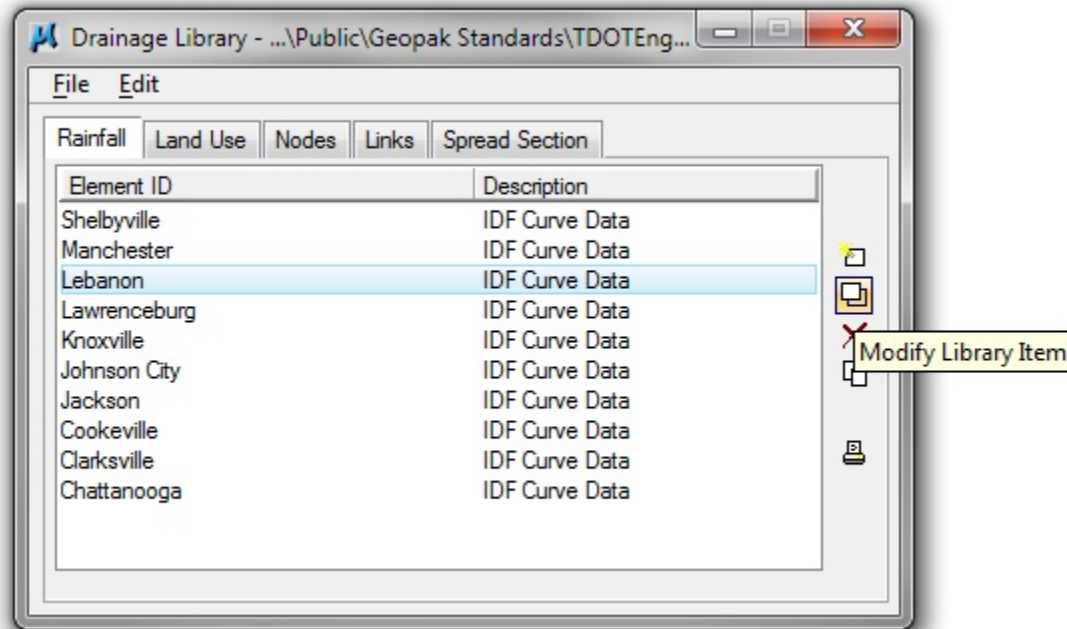


- **Rainfall** .. ..... Rainfall Data Source
- **Land Use** ..... Land Uses, their corresponding “C” values and symbology
- **Nodes** ..... Inlets, Junctions, Manholes, Outlets, etc.
- **Links** ..... Circular Pipes, Elliptical Pipes, Pipe-Arch pipes, Boxes, etc.
- **Spread Section** ..... Inventory of varying Spread Cross Sections



The **Rainfall** tab stores the rainfall data information to be used on GEOPAK Drainage Projects. GEOPAK Drainage supports rainfall sources in the form of intensity duration frequency (IDF) tables, or as coefficients for intensity-duration-equation formats.

**Step 2.** Select the **Rainfall** tab, highlight Lebanon, and select **Modify** to review the various options:



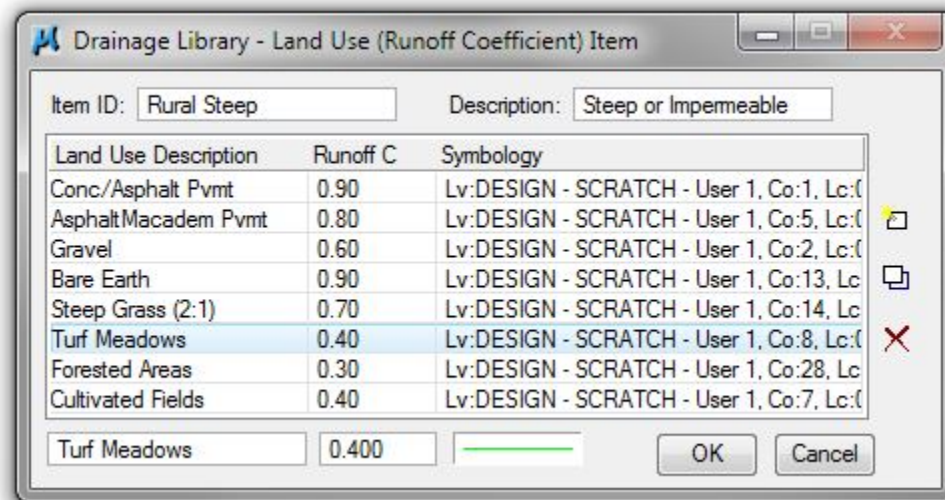
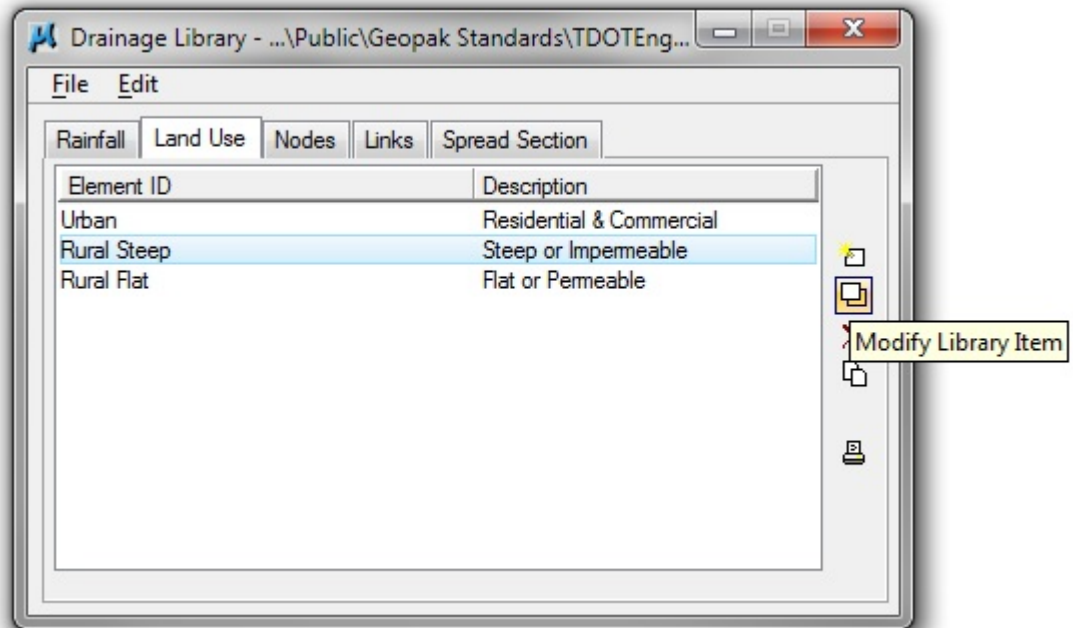
The table contains the Duration-Frequency Table for the Lebanon area.



# Exercise 1

The **Land Use** tab is used to store runoff coefficients ("C" values) and corresponding graphic symbology for each land use. Land uses can then be delineated automatically using the selected symbology.

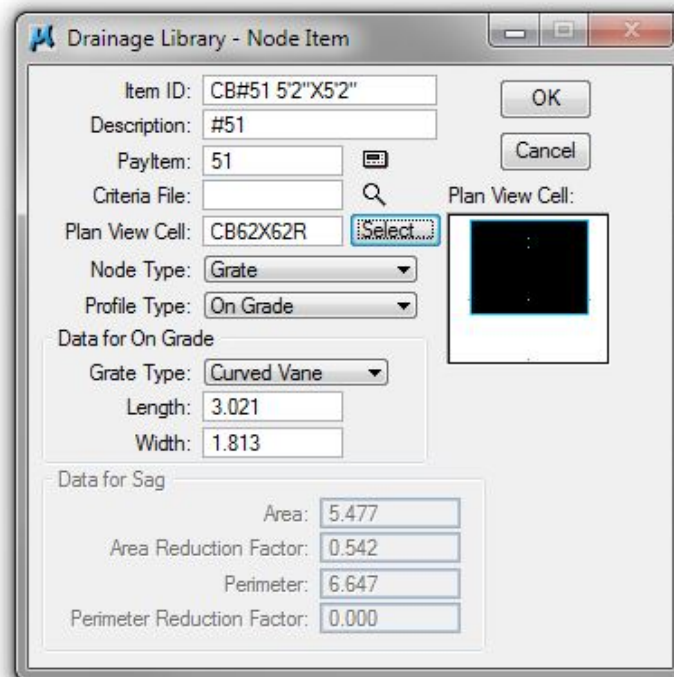
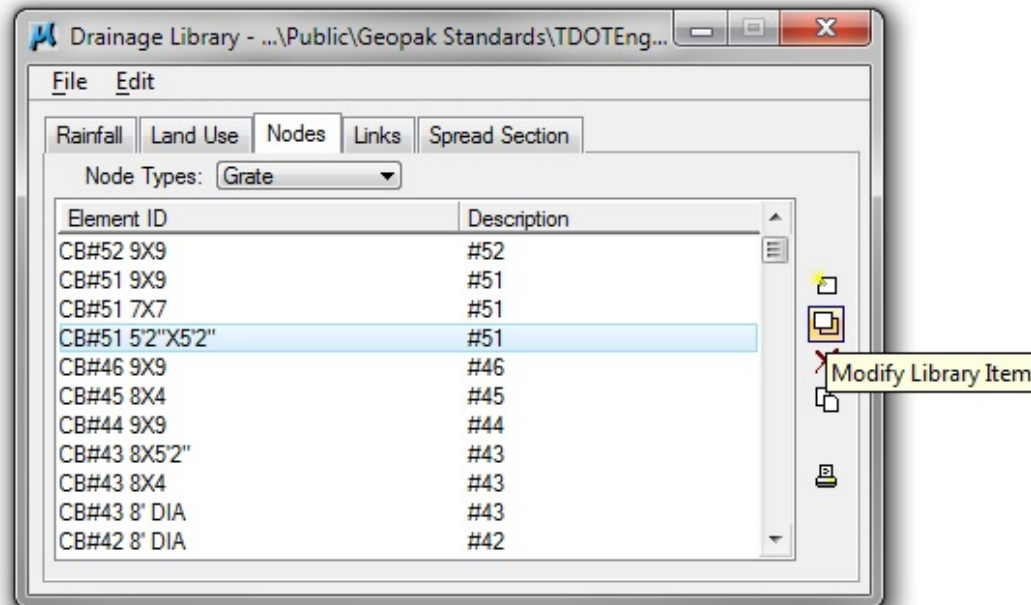
**Step 3.** Select the **Land Use** tab, highlight the Rural Steep item and select **Modify** to review the various options:



Note the various land uses and their associated symbology. Chapter 2 will discuss how to make a land use file.

The **Nodes** tab contains standard configurations for Grates, Curbs and Slotted drain inlets, as well as Junctions, Outlets and Other nodes. The description, plan view representation and dimensional information are stored for each node.

**Step 4.** Select the **Nodes** tab, highlight a Grate inlet and select **Modify** to review the various options:

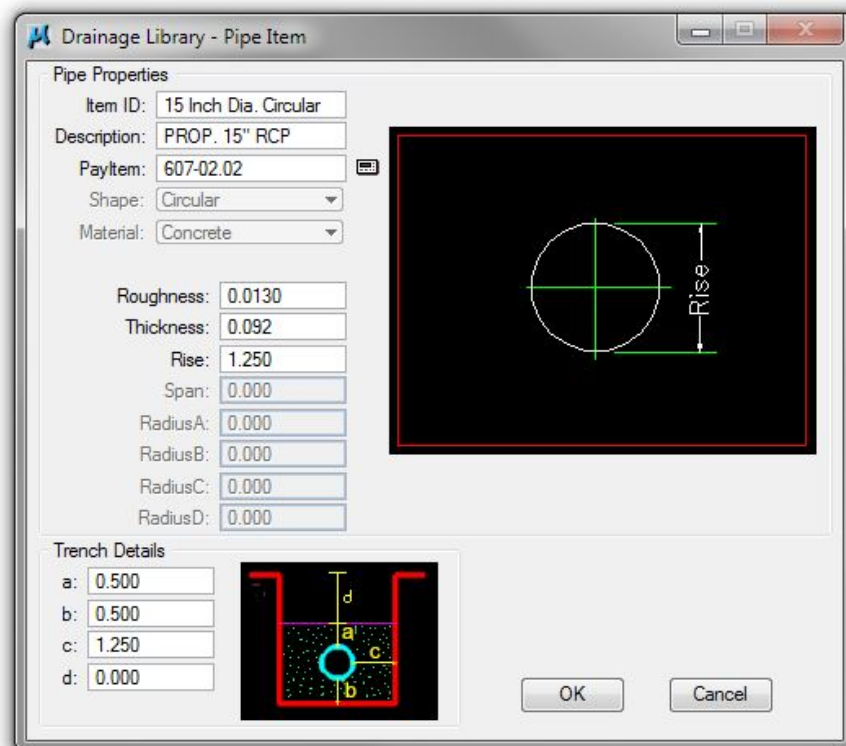
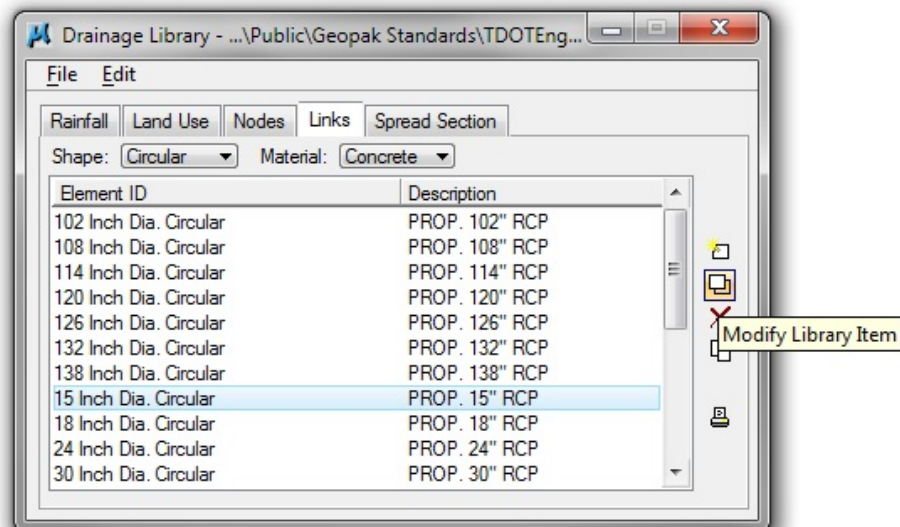


Note the various geometric values required for the nodes.

# Exercise 1

The **Links** tab contains all culverts to be used on drainage projects. Each link type is categorized by three properties: Shape, Material and Type (for some combinations of Shape & Material); and contains information regarding specific culvert geometry, default roughness coefficient and material combination.

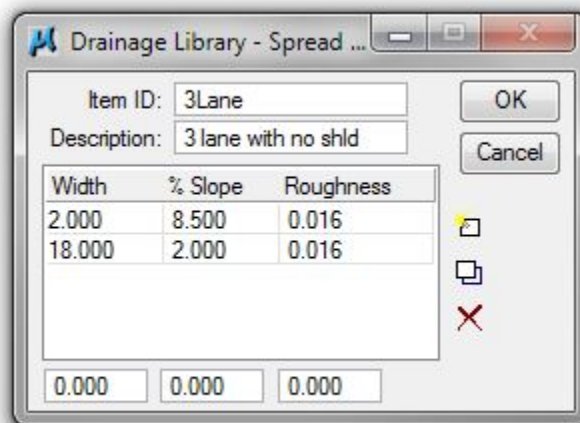
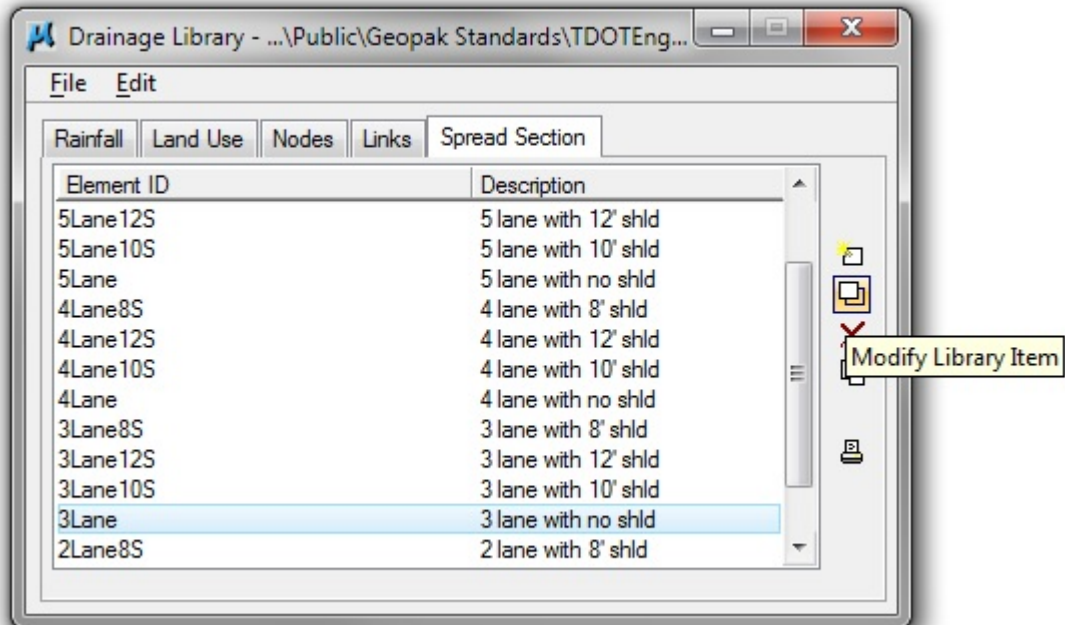
**Step 5.** Select the **Links** tab, select **Circular** from the Shape dialog box and **Concrete** from the Material dialog box. Highlight the first Circular Concrete pipe, and select **Modify** to review the various options:



Note the various geometric values required for the links.

The **Spread Section** tab stores standard spread cross sections for roadway, shoulders and gutter that can be used on drainage projects.

**Step 6.** Select the **Spread Section** tab, highlight any section, and select **Modify** to review the various options:



Note the spread cross section characteristics for the spread item.

# Land Use DGN Files

This chapter is provided for **REFERENCE ONLY**. We have provided the land use file for you so that all class participants will have the same areas.

For your own project, these exercises would have to be done prior to beginning GEOPAK drainage.

This exercise allows the user to create a Land Use file.

## 2.1 Land Use DGN Creation

The shapes created in the land use DGN file are used to specify run-off coefficients (C value) for different land use areas. These values are then used to calculate the composite run-off coefficient. This composite value is used in conjunction with rainfall data in the rational formula to calculate the Q discharge for the drainage area. This composite run-off coefficient can be manually calculated and entered as a value but by creating these shapes this can be done automatically for any drainage area specified on your project.

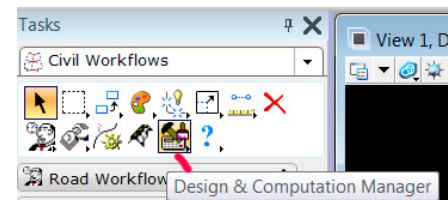
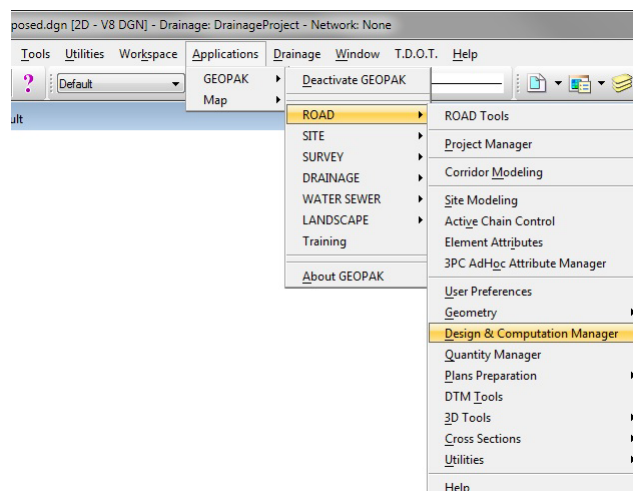
**Step 1.** Create a new DGN file for placement of land use shape elements from DGN seed file SEED2D.DGN and open it. Reference your proposed file, which contains proposed edges of pavement and slope lines. Also reference your survey topo file.

- Land use.dgn

**NOTE:** For further guidance in creating a new DGN file see **Exercise 2** of the [MicroStation V8 Manual](#)

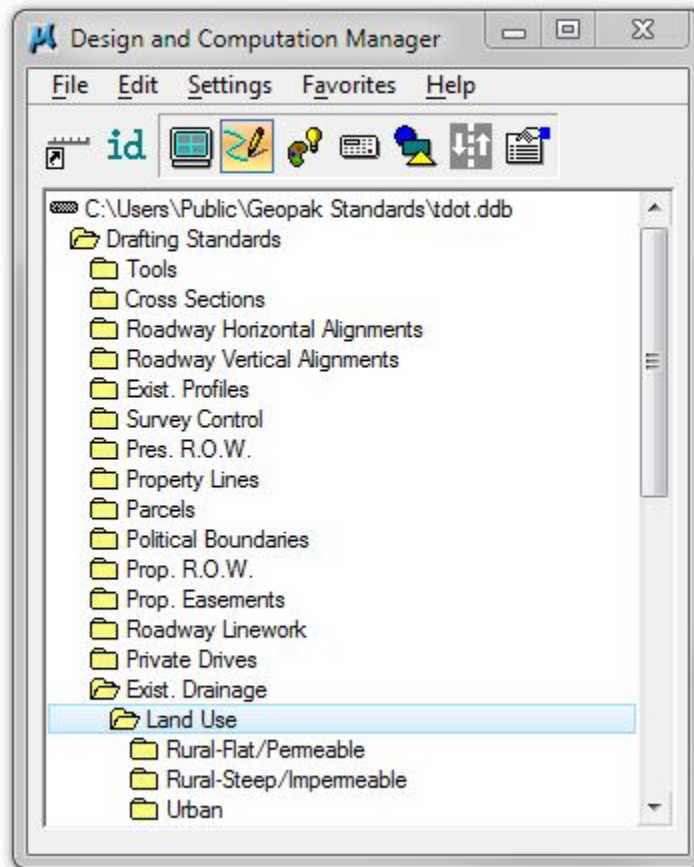
**Step 2.** Access **D & C Manager** from the MicroStation menu bar drop down location

**Applications>GEOPAK> Road>Design & Computation Manager**  
or from task navigation with Geopak's **Civil Workflows**, it is the second icon from the end on the right.



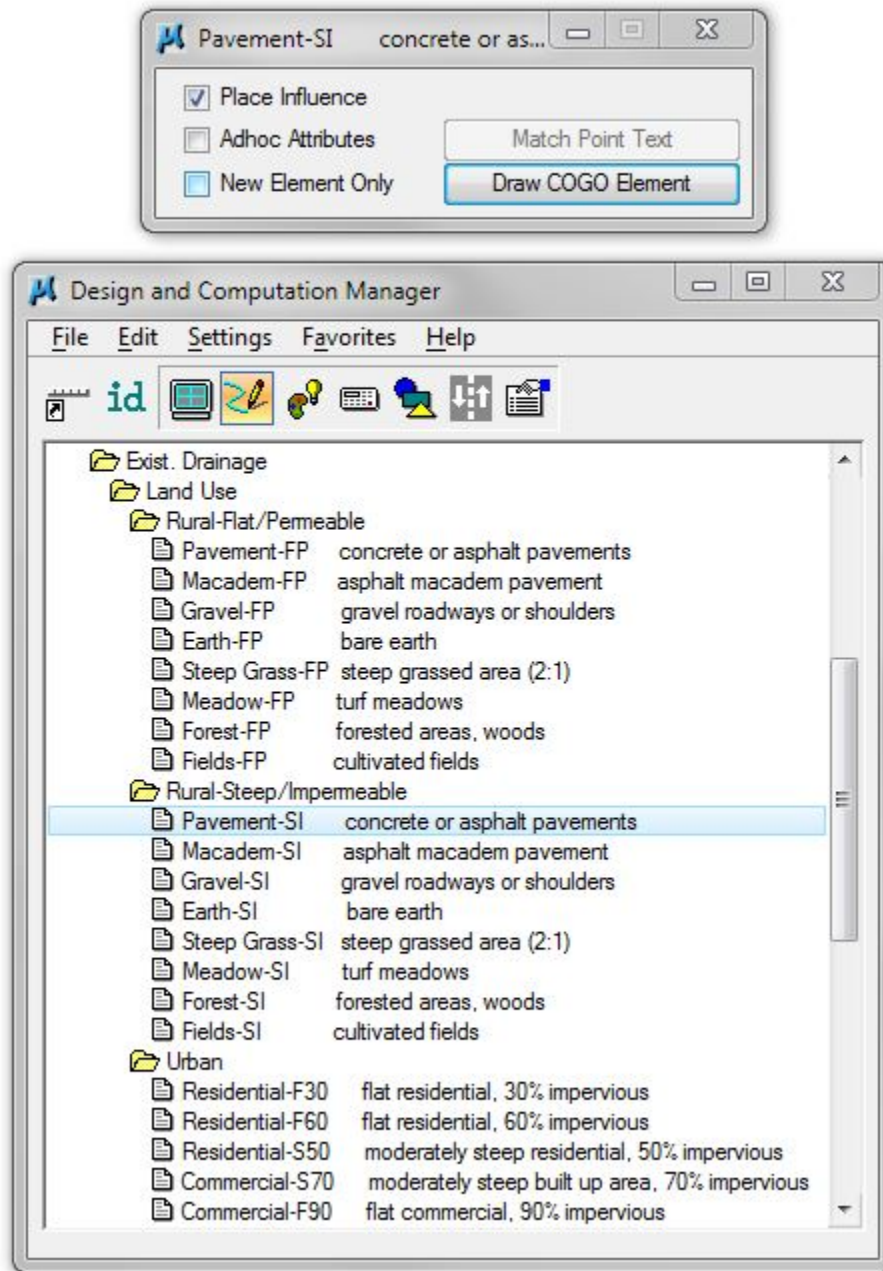


- Step 3.** In **D & C Manager** go to the land use category under **Drafting Standards\Exist. Drainage\Land Use**. There you will see the three categories of land use items used by T.D.O.T.



## Exercise 2

- Step 4.** Open the desired category and click on the land use item you wish to define on the project. Click on **Place Influence** in the D & C Manager control strip.



**NOTE:** You should only use types from one section (i.e. Rural-Flat/Permeable or Urban).



**Step 5.** Use any MicroStation shape command to draw shapes around the areas. You may wish to copy graphics from the reference files to create complex shapes. This could be the proposed edge of pavement lines from the proposed file to shape the pavement area or perhaps the edge lines from a parking lot or woods area from the survey topo file. Anytime you wish to change to a different land use type just click on it in **D & C Manager**. If you have shapes already defined simply use the MicroStation **Change Element Attributes** command to change their symbology.

**NOTES:**

Shapes must be continuous and closed. Set fill type to None.

It is not necessary to place shapes to cover all areas absolutely. Any areas not delineated by a land use shape will use the **Base C value** entered in the **Drainage Area Definition** dialog.

**Step 6.** Once shapes have been set up simply reference the DGN file to your proposed DGN file and they will be read when you use **Delineate Subareas** in the **Drainage Area Definition** dialog.

## DTM Drainage Tools

GEOPAK supports a wide range of tools that allow you to analyze and evaluate the drainage patterns of a GEOPAK Digital Terrain Model or TIN file. These tools are useful for delineating and distinguishing watersheds, flow paths, flow directions, and hydrographic features.

This exercise allows the user to become familiar with the Digital Terrain Model (or DTM) Drainage Tools.

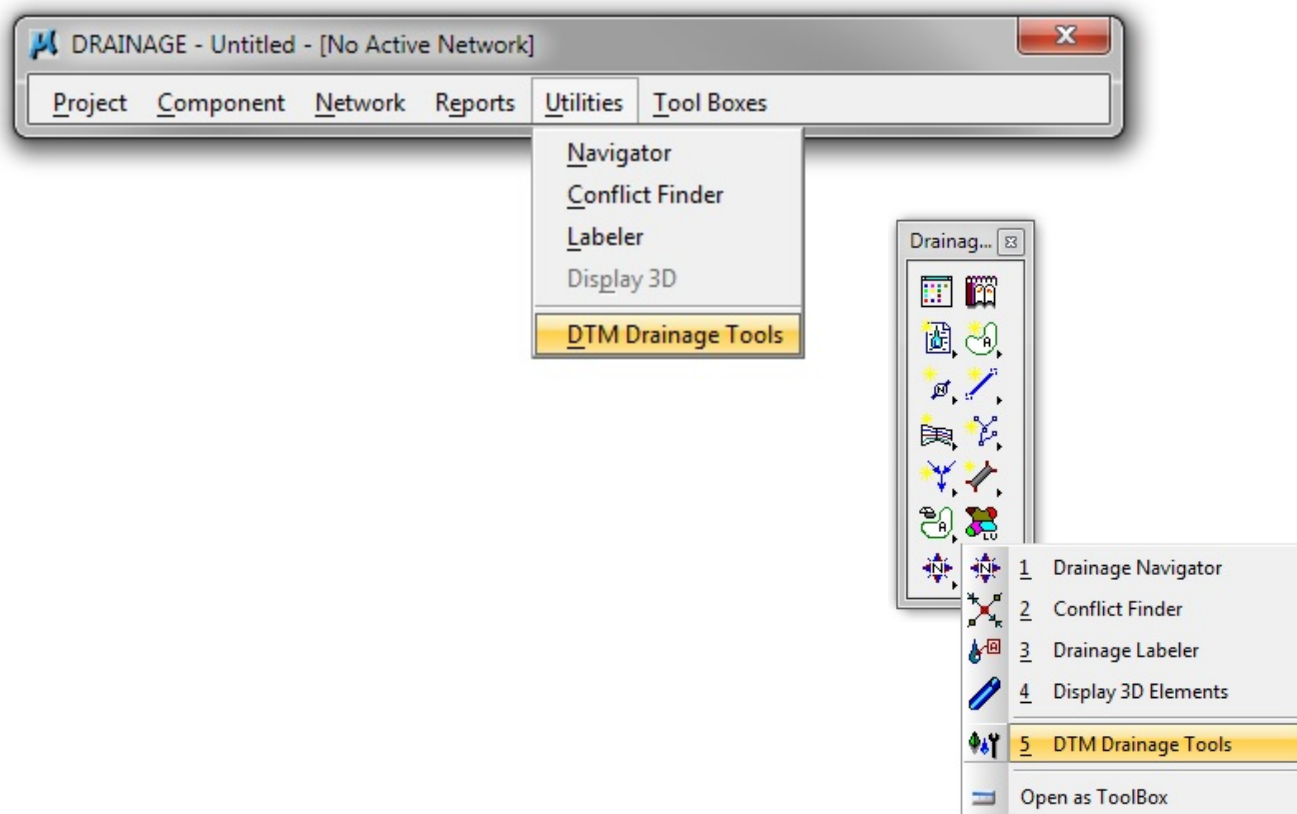
See Exercise 22 in the [TDOT GEOPAK Road Course Guide](#) for guidance in creating a final merged TIN file.

### 3.1 Accessing DTM Drainage Tools

**Step 1.** Open the file **DVSR1proposed.dgn** file.

**Note:** The landuse.dgn file has already been referenced into this file for your use. Refer to the previous exercise (Exercise 2) or to the [Land Use DGN Creation](#) document for instructions on creating the land use file.

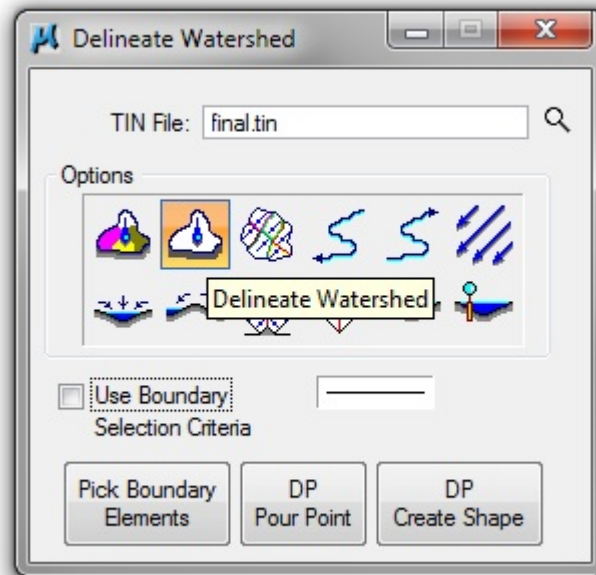
**Step 2.** Open GEOPAK Drainage and select from the Drainage Menu Bar:  
**Utilities > DTM Drainage Tools**



## 3.2 Delineate Watershed

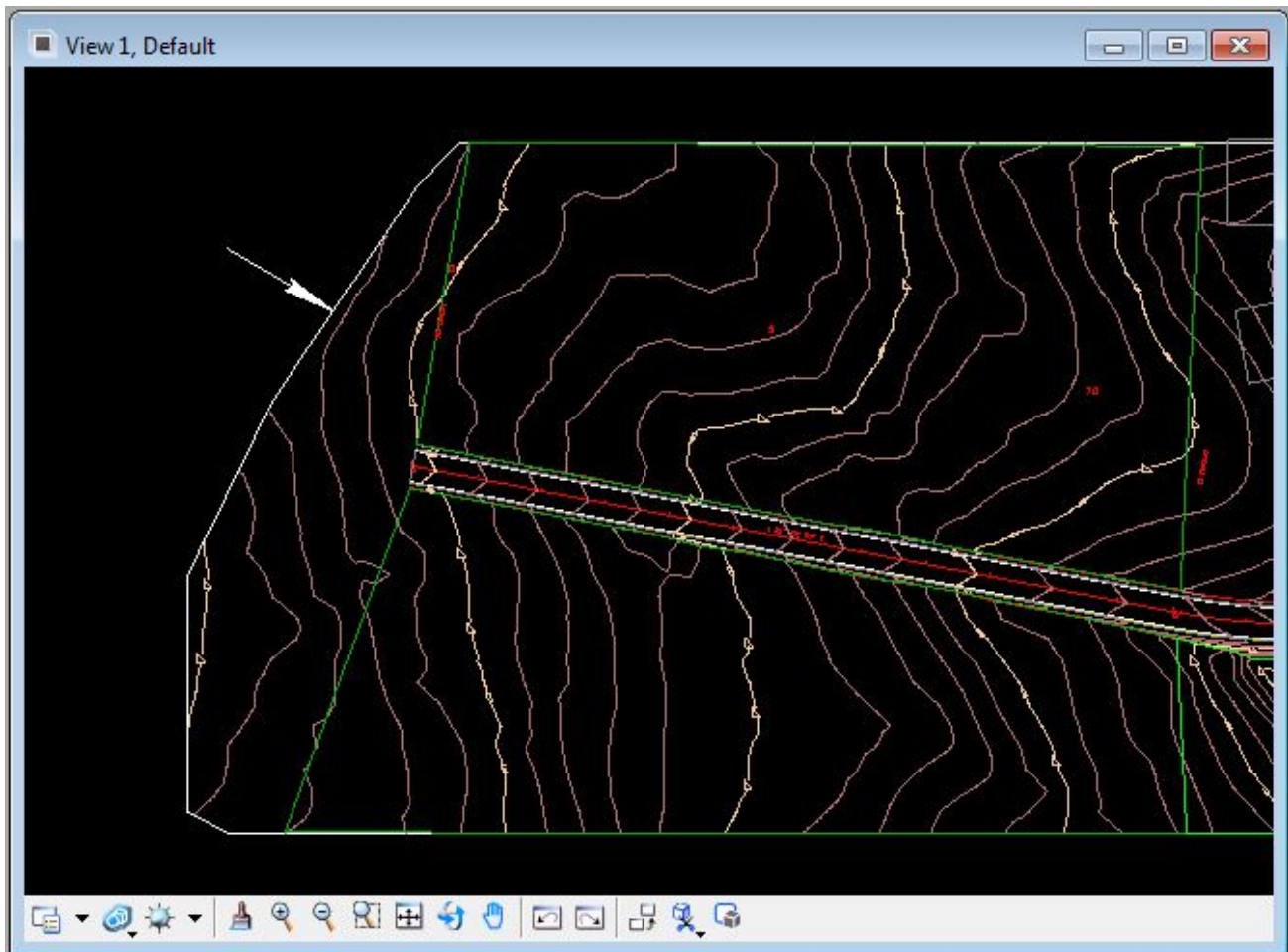
The Delineate Watershed tool outlines and defines a watershed at any location within the TIN surface. The pour point of the watershed is the most downstream point of a desired watershed. Once a data point representing the pour point of the watershed is indicated the contributing watershed area is computed and delineated. Pour points must be located near sumps (i.e. low points) in the terrain since a point lying on the side of a hill does not actually have a contributing area. .

**Step 1.** Use the Select File button to select the final merged TIN for the project. Then select the DTM Drainage Icon **Delineate Watershed**.

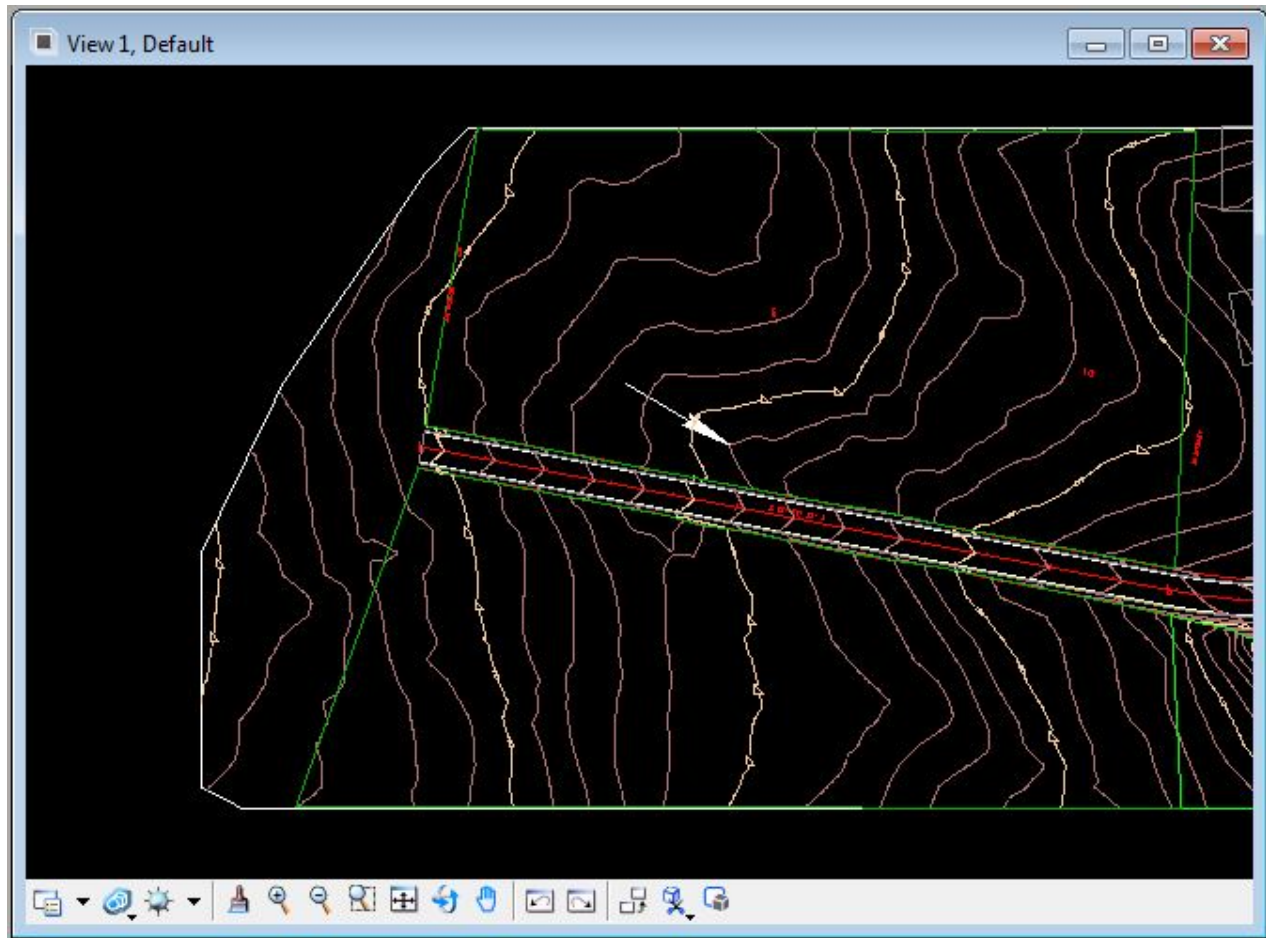


## Exercise 3

**Step 2.** Click the **Pick Boundary Elements** button and select the element representing the tin hull (the boundary of the TIN file) as shown in the screenshot below. Data Point to accept.



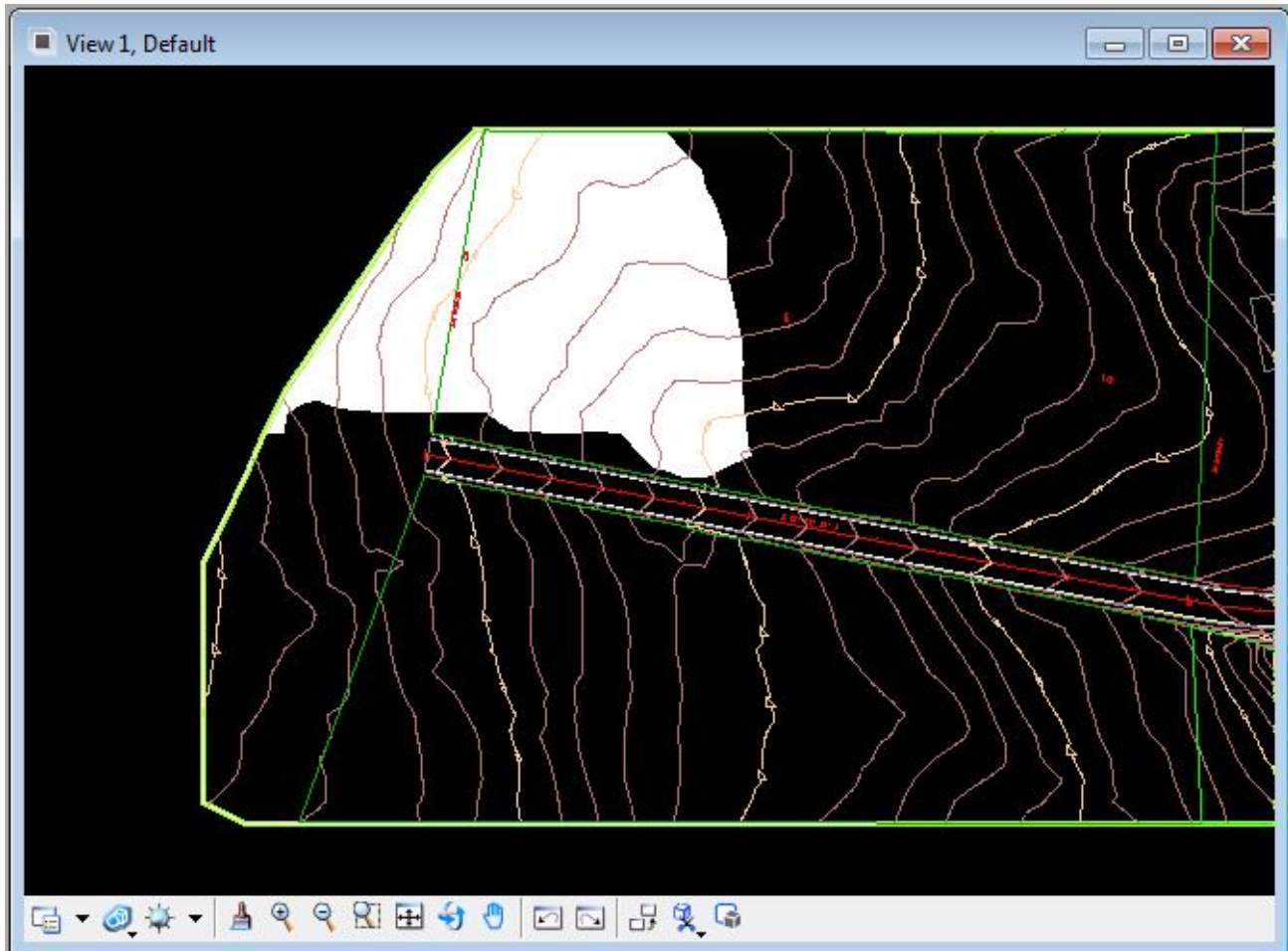
**Step 3.** Click the **DP Pour Point**. Data Point in the dgn file in the approximate location shown below:



## Exercise 3

**Step 4.** Click the **DP Create Shape** button and data point inside the drainage area delineation from the previous step. This procedure will place a temporary fill in the drainage area. Data Point to accept this shape and Update the Microstation View to remove the temporary fill. The Drainage Area Shape has been drawn in the dgn file.

**NOTE:** Scrolling or zooming between Step 3 and Step 4 will cause the temporary watershed delineation to disappear. However, the information is still present and following Step 4 will still create the Drainage Area Shape.



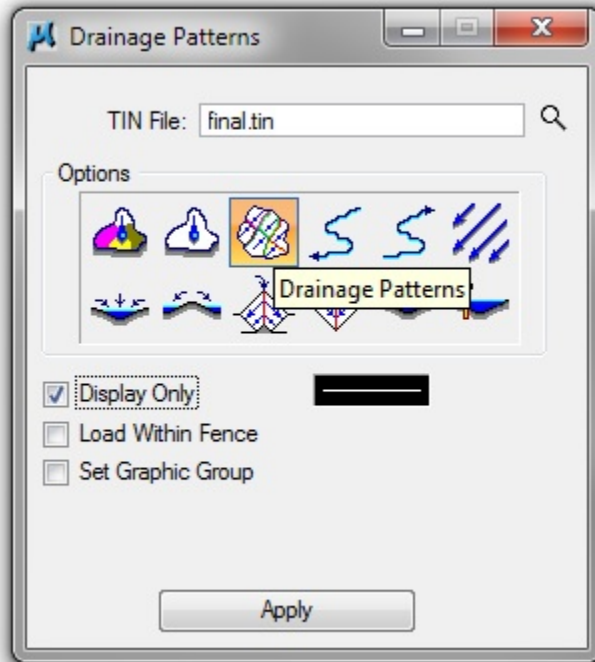


### 3.3 Drainage Patterns

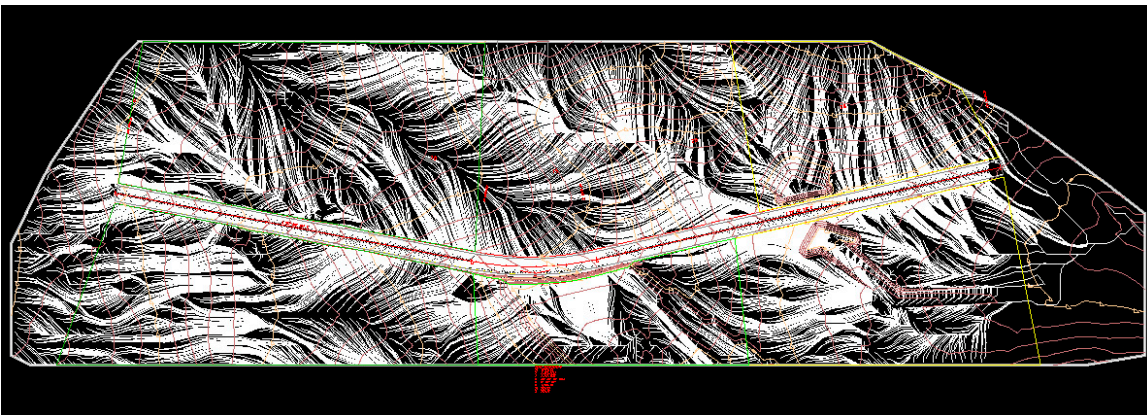
The Drainage Patterns tool evaluates the flow paths contained within the TIN. This tool performs a downstream trace from the centroid of each triangle.

**Step 1.** Select the DTM Drainage Icon **Drainage Patterns**. Toggle ON Display Only and click the **Apply** button to exhibit the Drainage Patterns for the tin file.

**NOTE:** Throughout this exercise, Display Only will be chosen, if available, so that the graphics will delete when the view is refreshed.



**NOTE:** Pressing the Escape button (on the keyboard) will terminate the current process before completion.

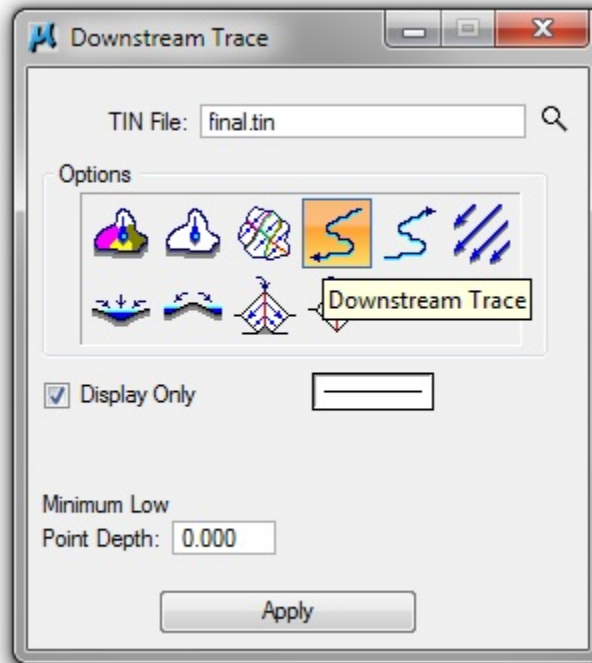




### 3.4 Downstream Trace

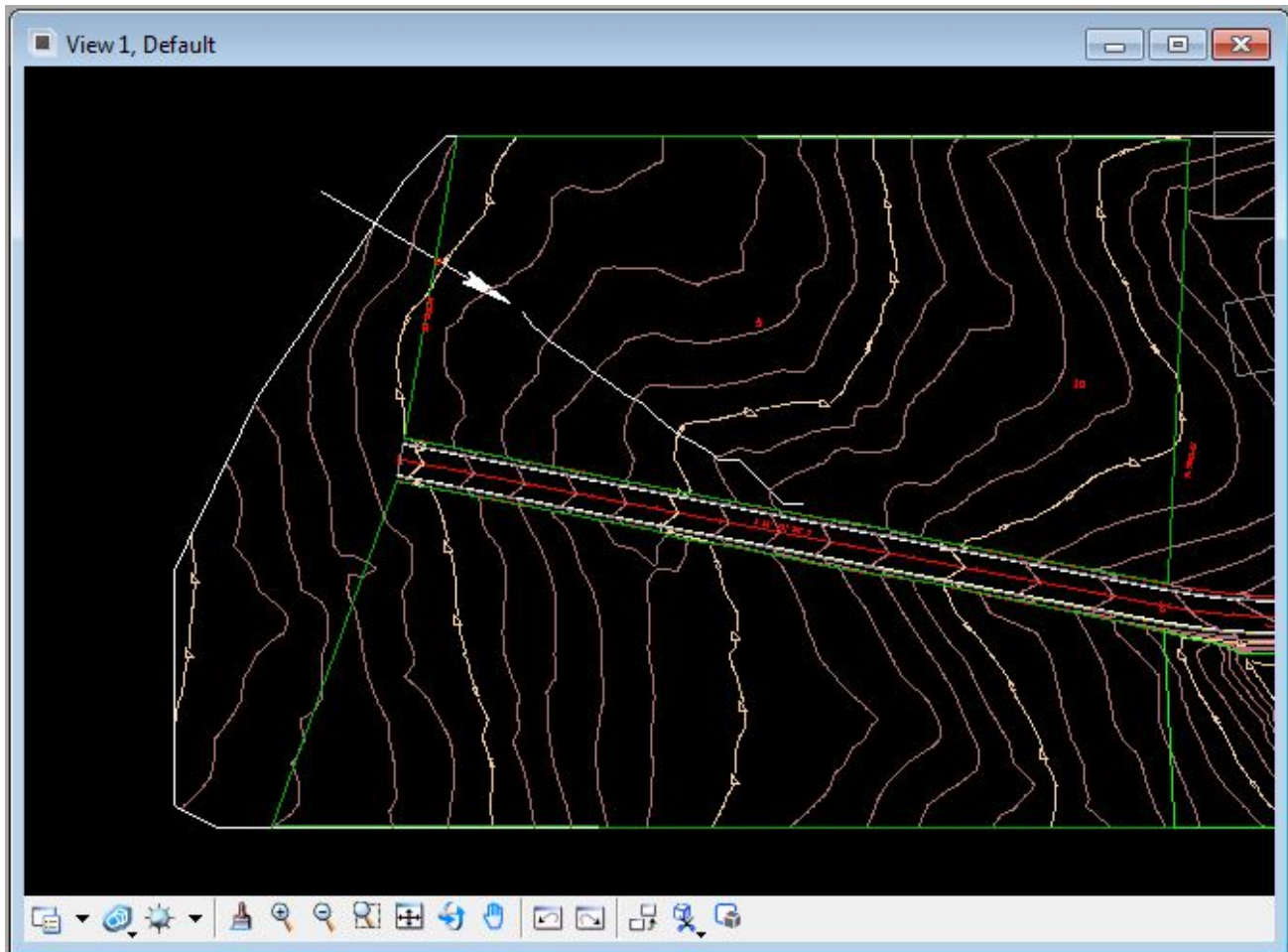
The Downstream Trace tool delineates the flow path downstream from a given point in the TIN. The indicated path follows the steepest descent from the point through the TIN terminating at a low point or the edge of the TIN.

**Step 1.** Select the DTM Drainage Icon **Downstream Trace**. Toggle ON Display Only and click the **Apply** button.



**NOTE:** Setting the Minimum Low Point Depth to a value above 0.00 will allow the downstream trace to pass through small, localized depressions and continue downstream.

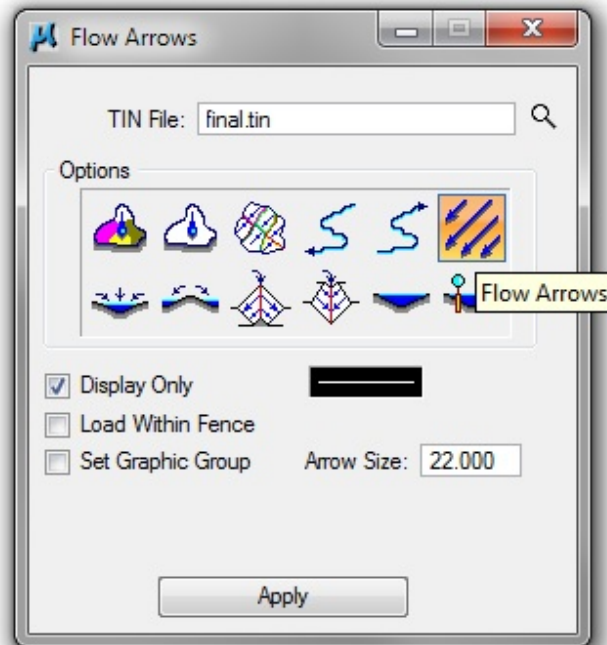
- Step 2.** Click in the design file within the limits of the tin hull. A downstream trace will appear from the cursor data point location to the nearest low point to which the water will drain.



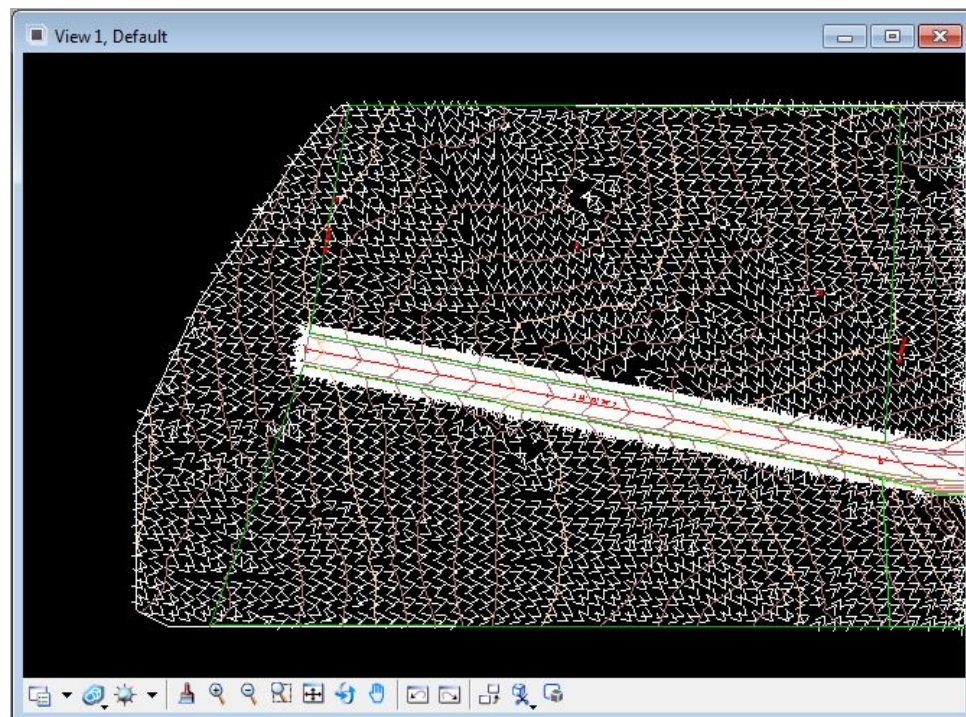
## 3.5 Flow Arrows

The Flow Arrows tool indicates the direction of flow within the triangles of the TIN.

**Step 1.** Select the DTM Drainage Icon **Flow Arrows**. Toggle ON Display Only, set the arrow size as shown and click the **Apply** button.



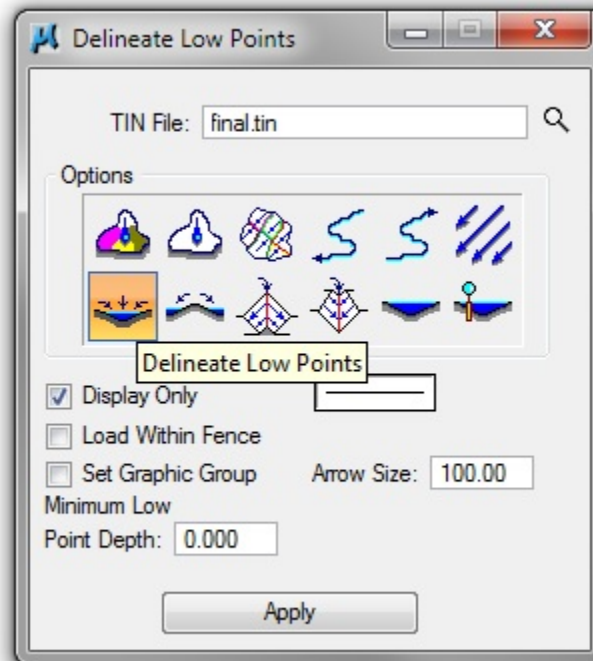
The Drainage Flow Arrows are drawn in the design file.



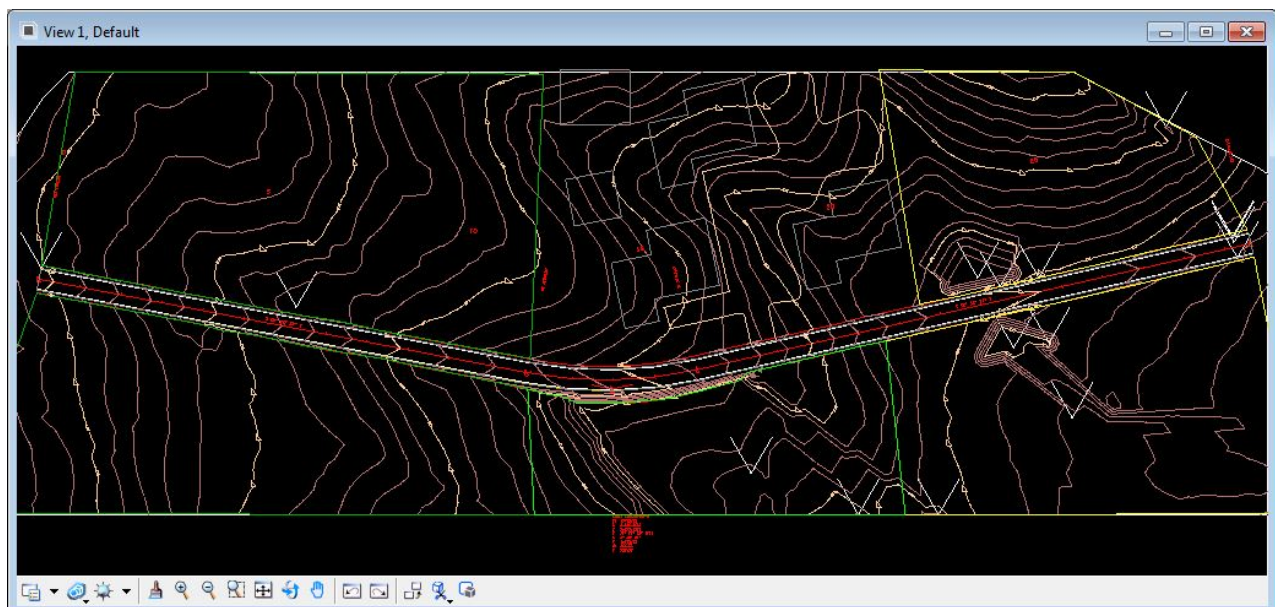
### 3.6 Delineate Low Points

The Delineate Low Points tool locates all low points within a region of a TIN. A flow arrow is placed and the text "LP" is placed at the triangle vertex. This is an excellent tool to use when choosing an initial location for catch basins on sag points as well as locations in ponding areas.

**Step 1.** Select the DTM Drainage Icon **Delineate Low Points**. Toggle ON Display Only, set the arrow size as shown, and click the **Apply** button.



The Low Points are drawn in the design file.

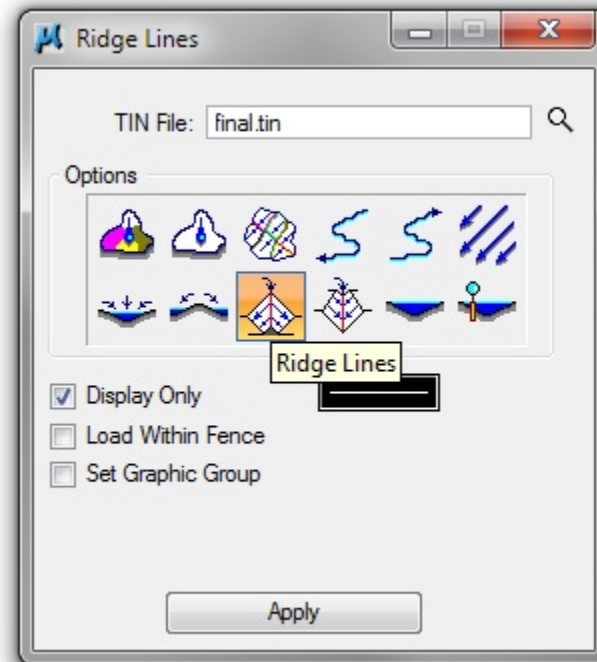




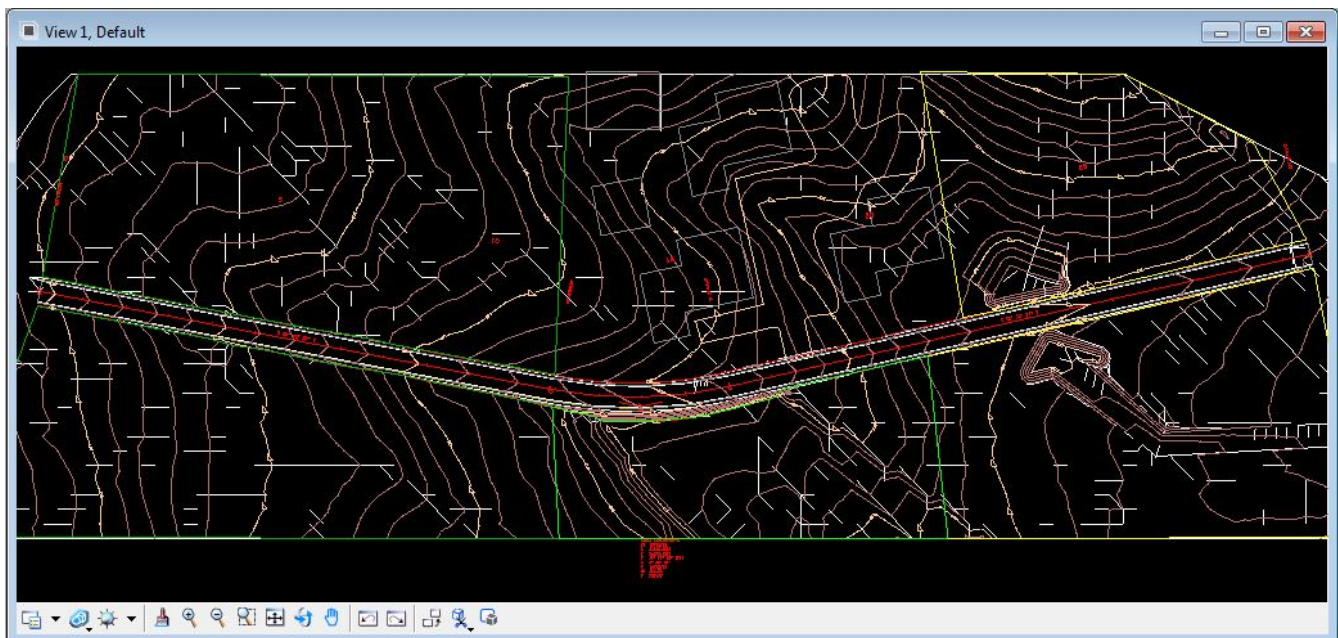
### 3.7 Ridge Lines

The Ridge Lines tool indicates the ridgelines within a TIN. A ridge line is defined as a triangle edge where the flow on each side of the edge is away from the edge.

**Step 1.** Select the DTM Drainage Icon **Ridge Lines**. Toggle ON Display Only, and click the **Apply** button.



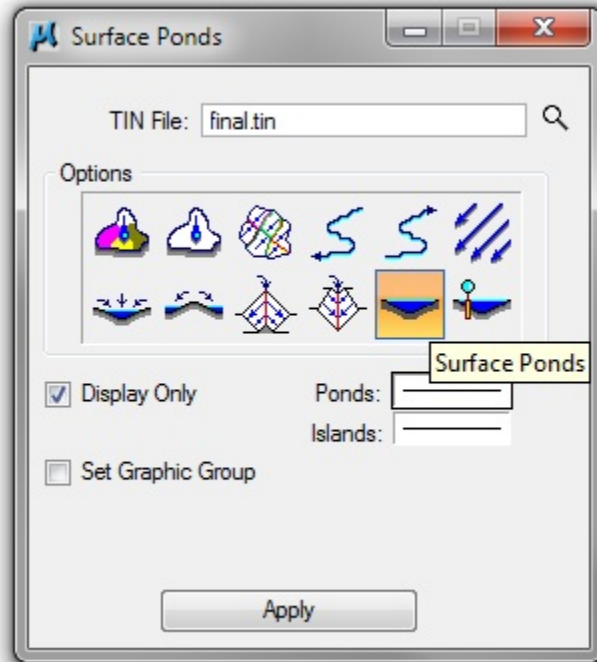
The Ridge Lines are drawn in the design file.



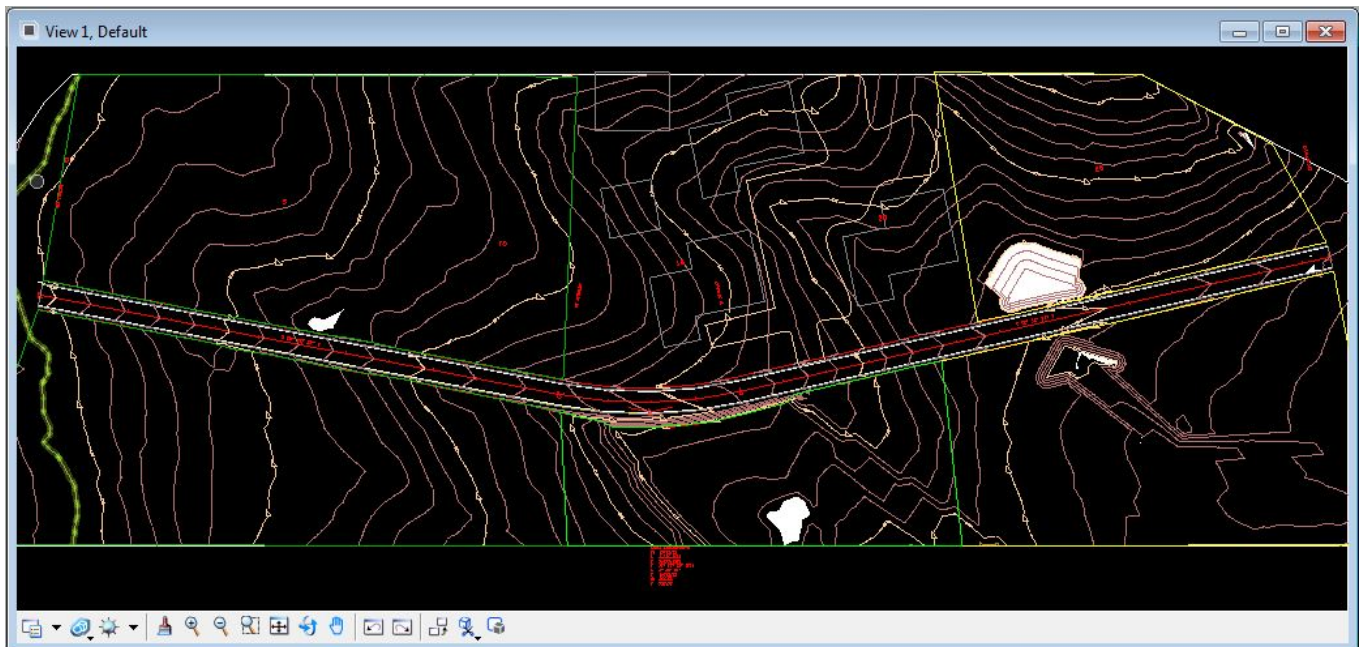
### 3.8 Surface Ponds

The Surface Ponds tool delineates the area(s) of ponded water within the specified TIN.

- Step 1.** Select the DTM Drainage Icon **Surface Ponds**. Toggle ON Display Only, and click the **Apply** button.



The surface ponds are drawn in temporary fill as shown below:

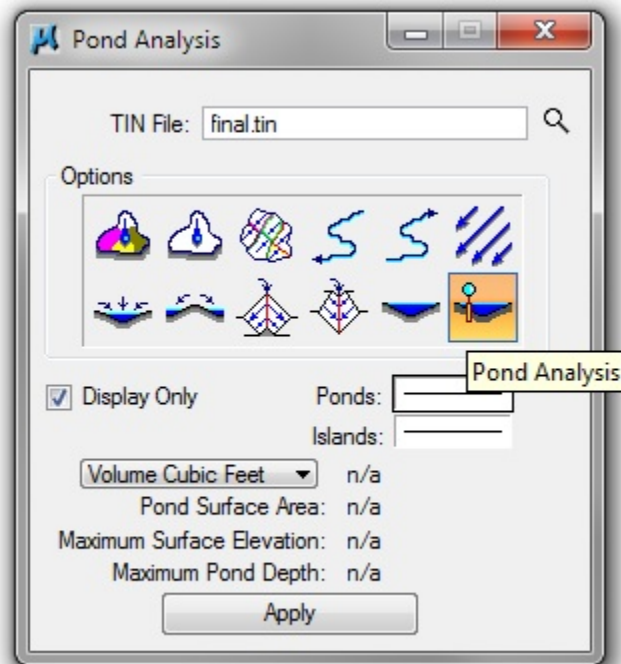




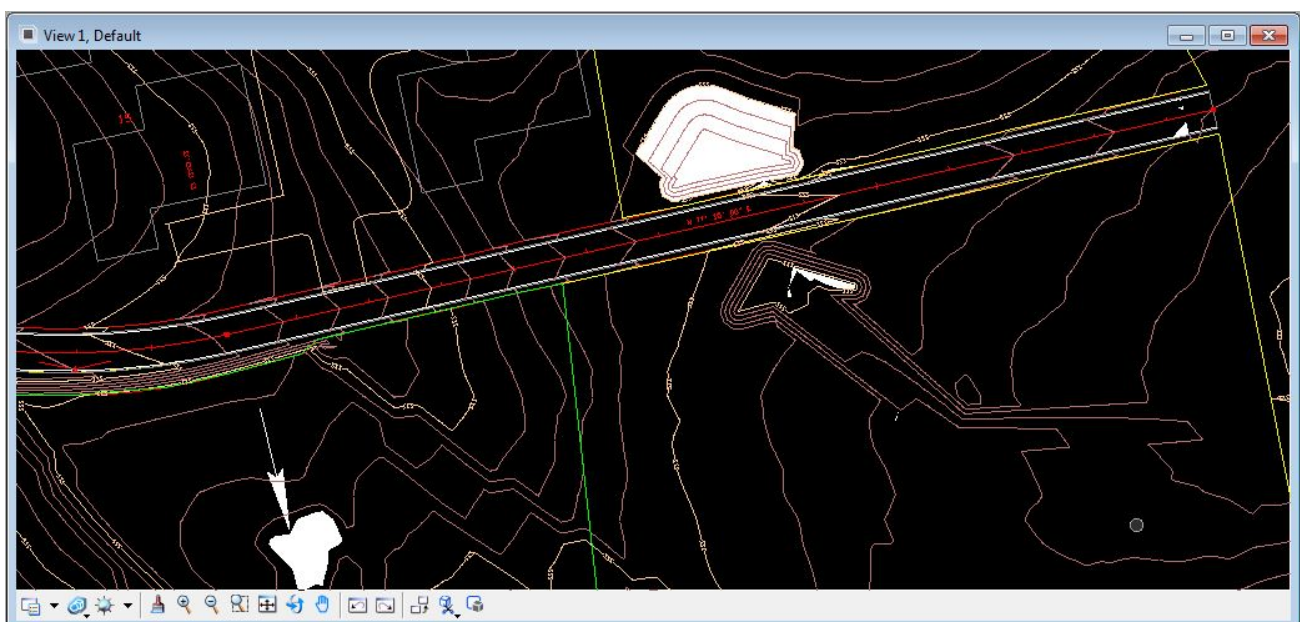
## 3.9 Pond Analysis

The Pond Analysis tool traces a point downstream to a low point and fills it giving the volume, maximum depth, and maximum elevation. In addition, the pond delineation is graphically displayed

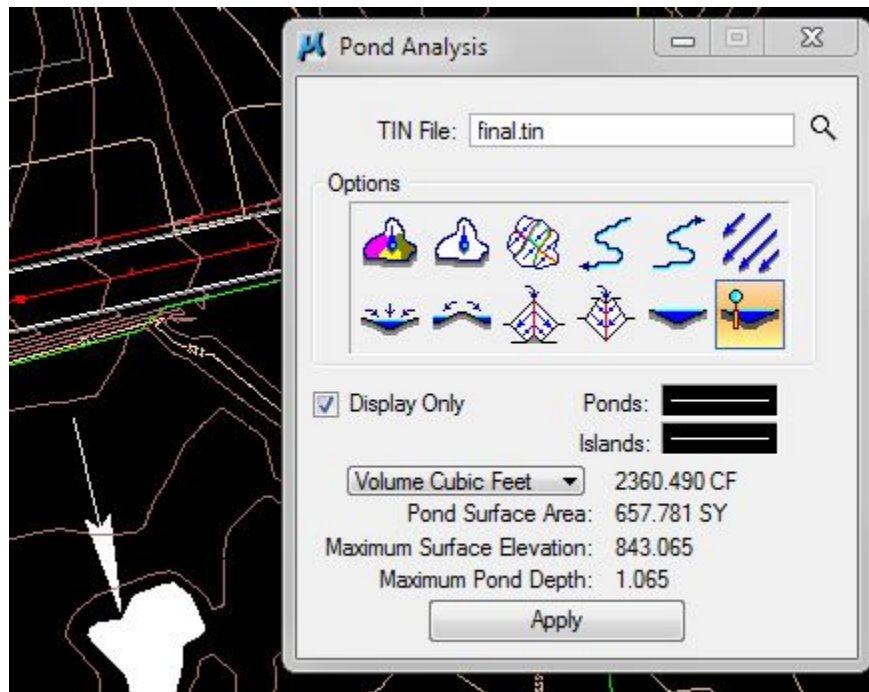
**Step 1.** Select the DTM Drainage Icon **Pond Analysis**. Toggle ON Display Only, and click the **Apply** button.



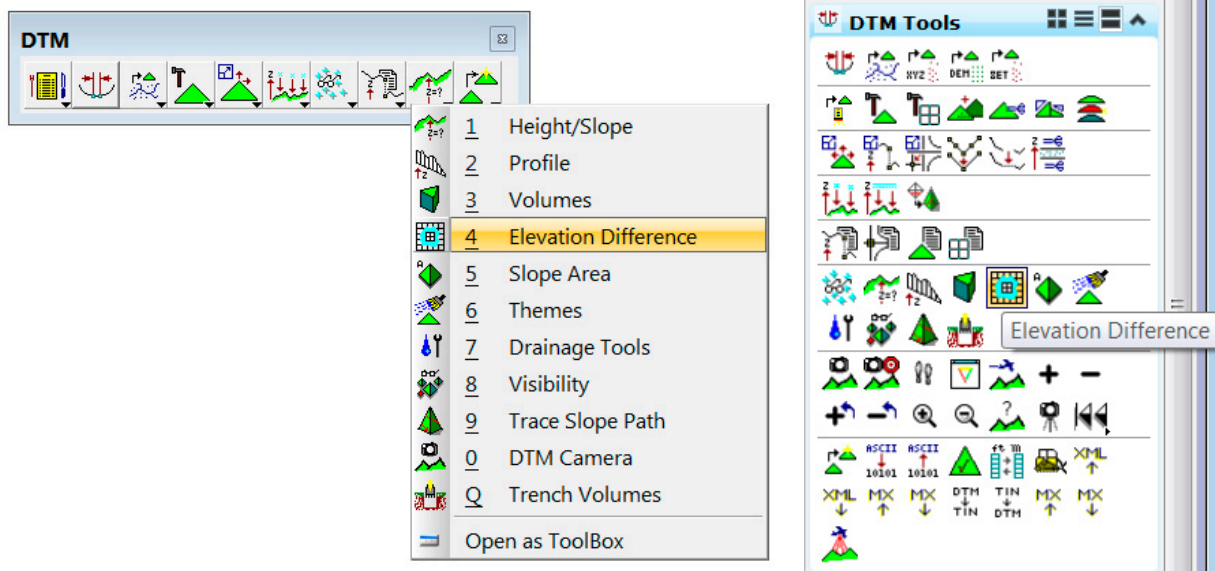
**Step 2.** Data Point near the location shown below:



**Step 3.** The Pond is filled and pond characteristics computations performed:



**NOTE:** Other DTM Tools are available from **Applications> GEOPAK> ROAD>DTM TOOLS**. Surface analysis tools are the second from the end. All of these tools are available under task navigation through **DTM Tools** when Geopak's Civil Workflows is active.



## Culverts

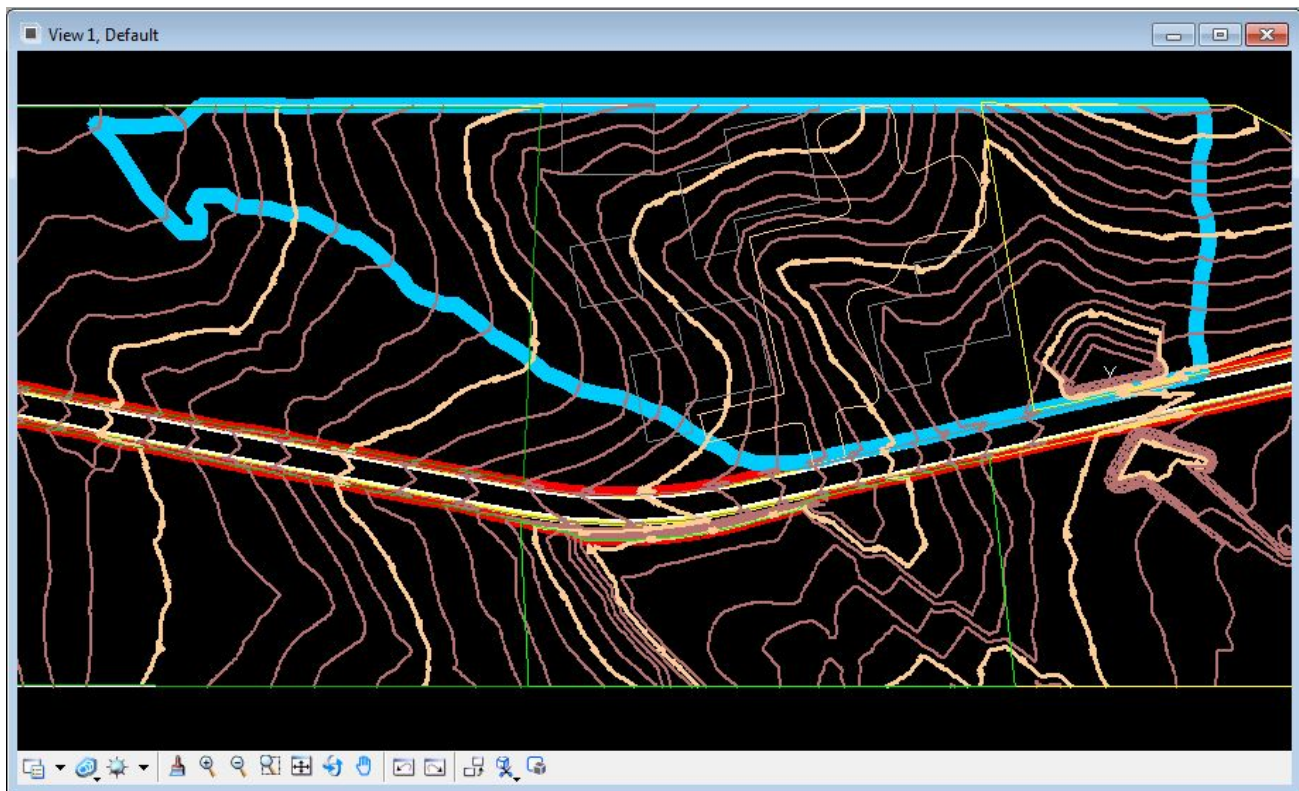
This exercise shows the user how to use the culvert module to design a culvert. The culvert module acts as a standalone component of GEOPAK Drainage, meaning it does not directly interact with Drainage Areas, Nodes, Links or Networks.

### 4.1 Design the Drainage Area

**Step 1.** The physical Drainage Area boundary may be delineated using a digital terrain model (DTM Drainage Tools, Exercise 3), simply drawn with MicroStation, or just keyed-in as a total area value (in units of acres or hectares).

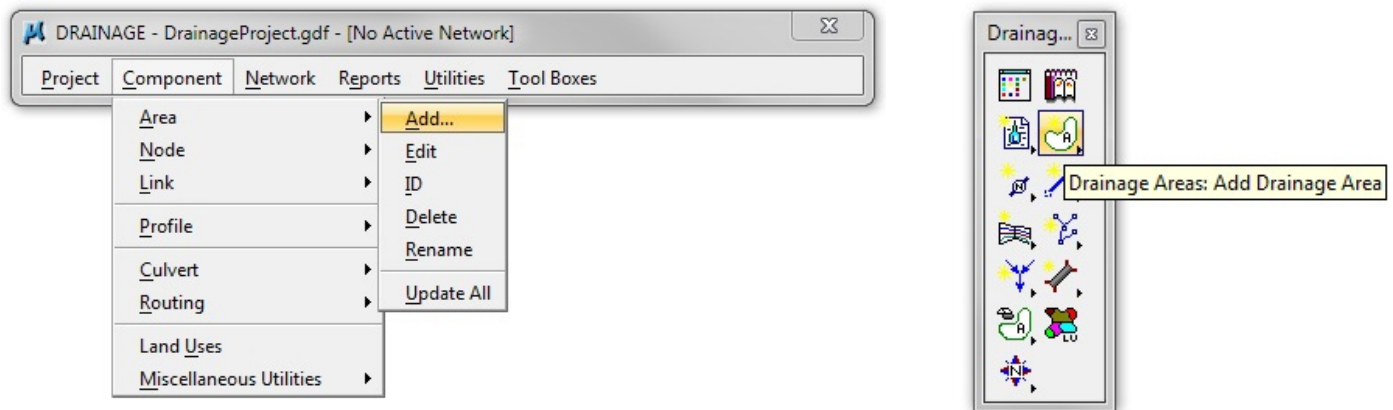
The following shape will be used below as the drainage area for this exercise.

**NOTE:** The area shown below on level SURVEY - DRAINAGE - Area Shapes extends to the limits of the current TIN file. Inspection of the contours will reveal that the drainage area most likely extends beyond these limits. **Appendix B** will discuss options to approximate the full extent of the drainage area.

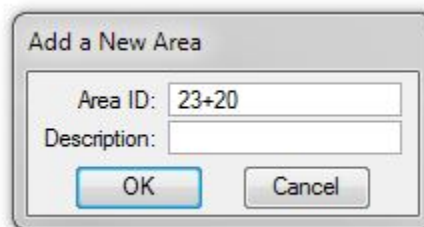




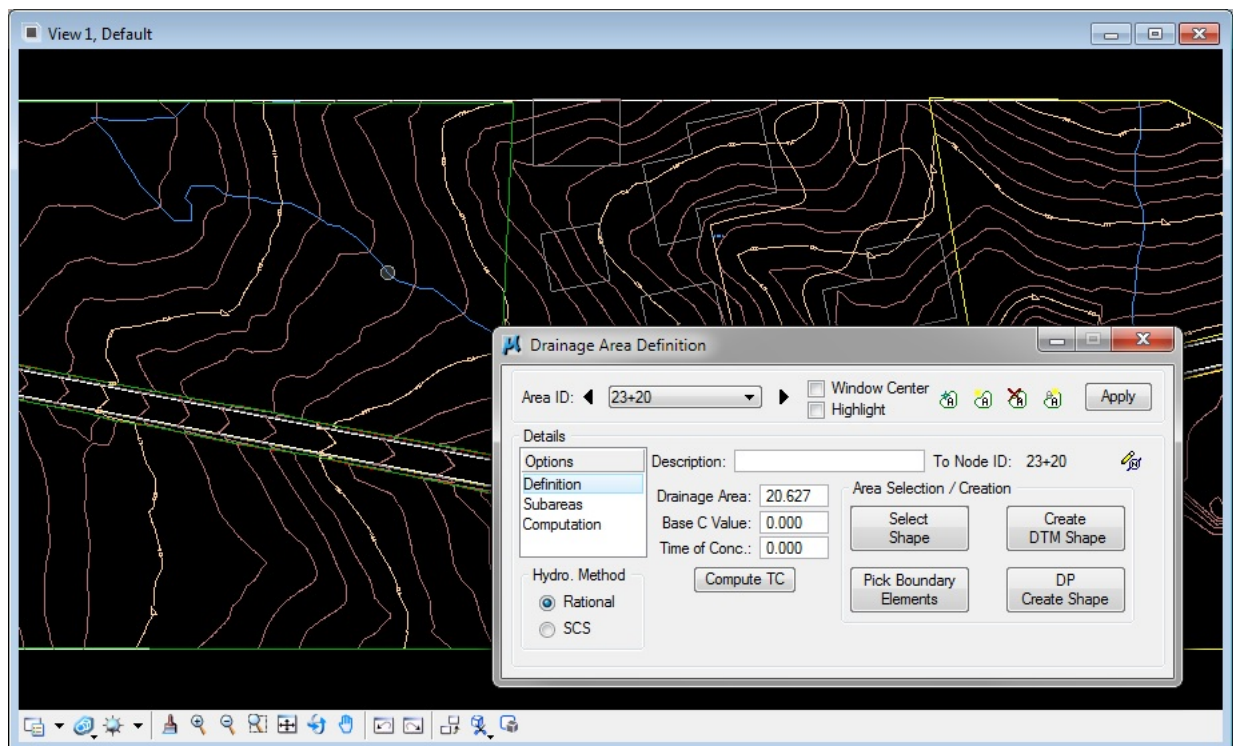
**Step 2.** From the GEOPAK Drainage menu bar select **Component>Area>Add**.



Type in **23+20** for the **Area ID**. Click OK.

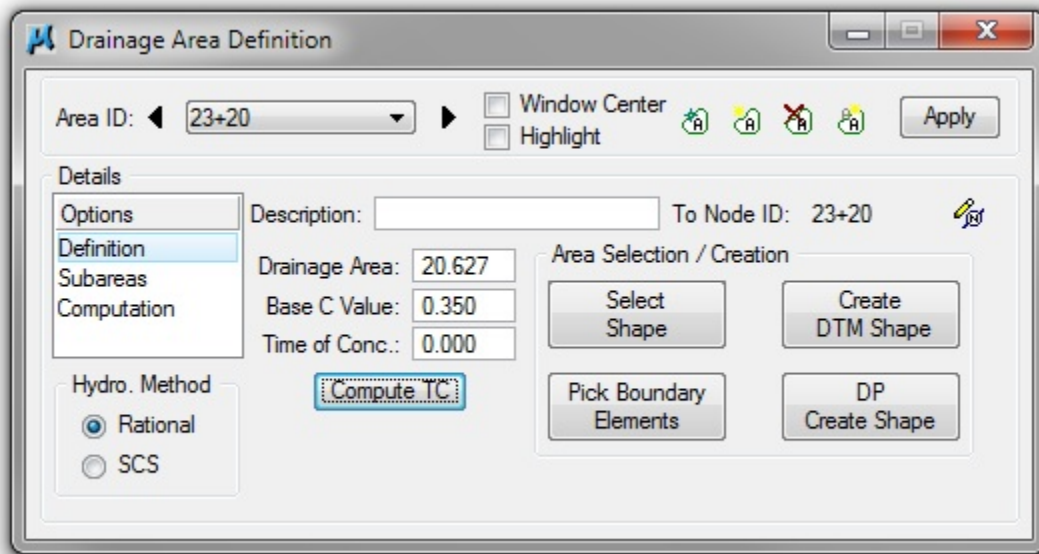


**Step 3.** Click the Select Shape button. Select and data point to accept the shape shown in the first step. The area is automatically calculated.

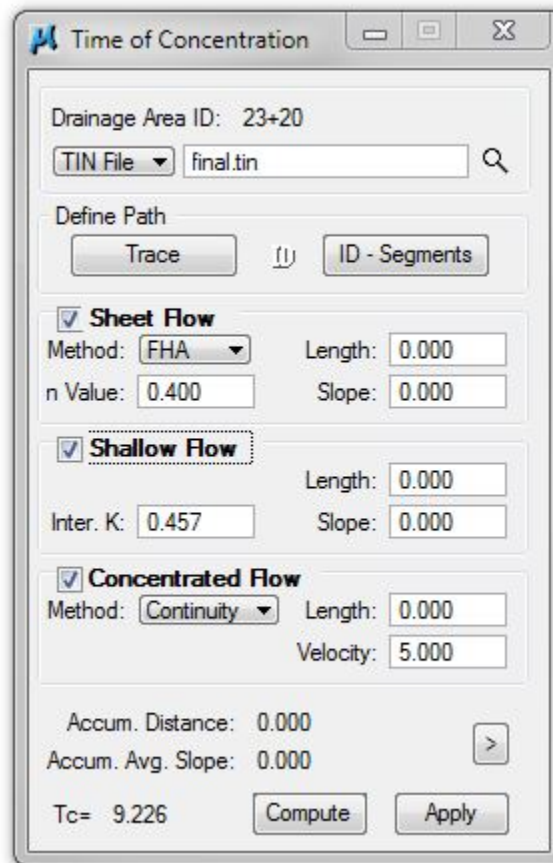


## Exercise 4

**Step 4.** Set the **Base C Value** to 0.350 and click on **Compute TC**



When the following Dialog will appears, use the explorer button to select the correct TIN file.



**Step 5.** Expand window to show details and set **Max Sheet Flow Distance** to **100'** and **Max Shallow Flow Distance** to **300'**.

Collapse the window, toggle ON Sheet Flow, Shallow Flow and Concentrated Flow and fill in the values as follows:

**n Value: 0.400**

**Inter. K: 0.457**

**Velocity: 5.000**

**n Values** for different surface types are available in the [TDOT Drainage Manual](#), Table 4-3 *Manning's n Values for Overland Flow*

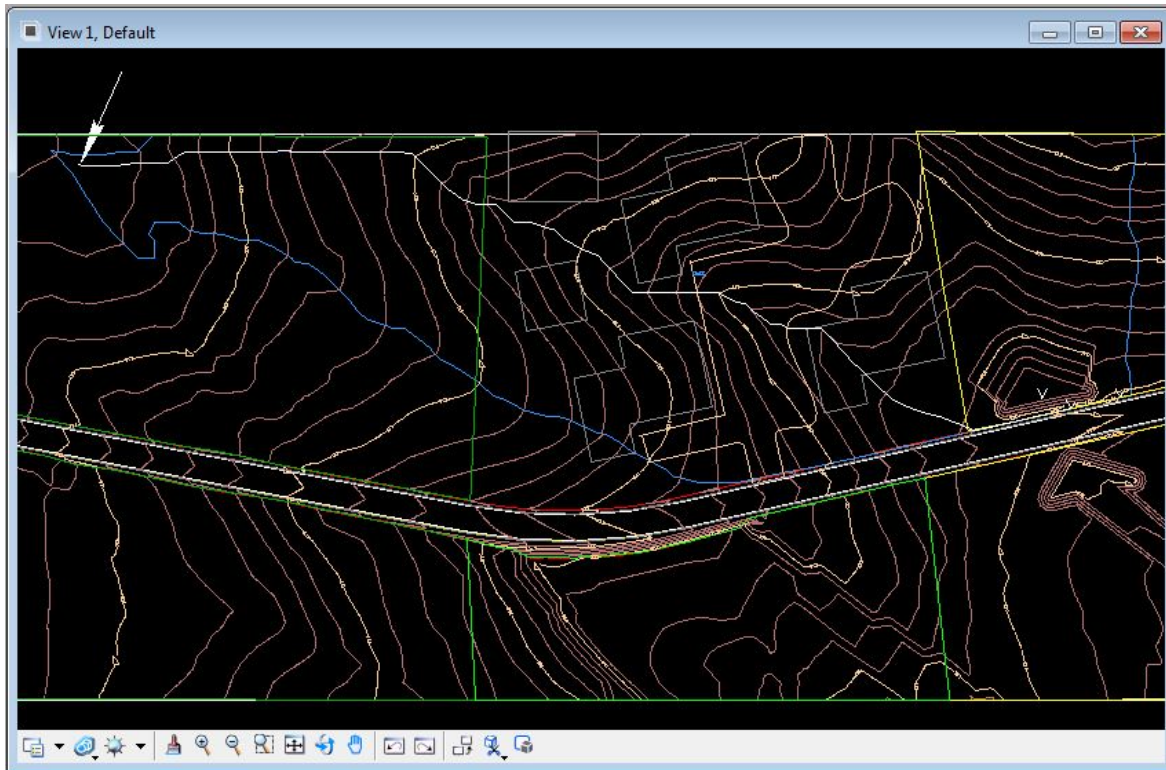
**Inter. K** values are below:

Land Cover / Flow Regime	k
Grassed waterway (shallow concentrated flow)	0.457
Unpaved (shallow concentrated flow)	0.491
Paved area (shallow concentrated flow); small upland gullies	0.619



## Exercise 4

**Step 6.** Click **Trace** and data point at the furthest hydraulic point. Once values are calculated, click **Compute**. Then click **Apply**.



**Time of Concentration**

Drainage Area ID: 23+20

TIN File: final.tin

Define Path

Trace (I) ID - Segments

☒ **Sheet Flow**

Method: FHA Length: 100.000

n Value: 0.400 Slope: 1.302

☒ **Shallow Flow**

Length: 300.000

Inter. K: 0.457 Slope: 3.388

☒ **Concentrated Flow**

Method: Continuity Length: 1660.038

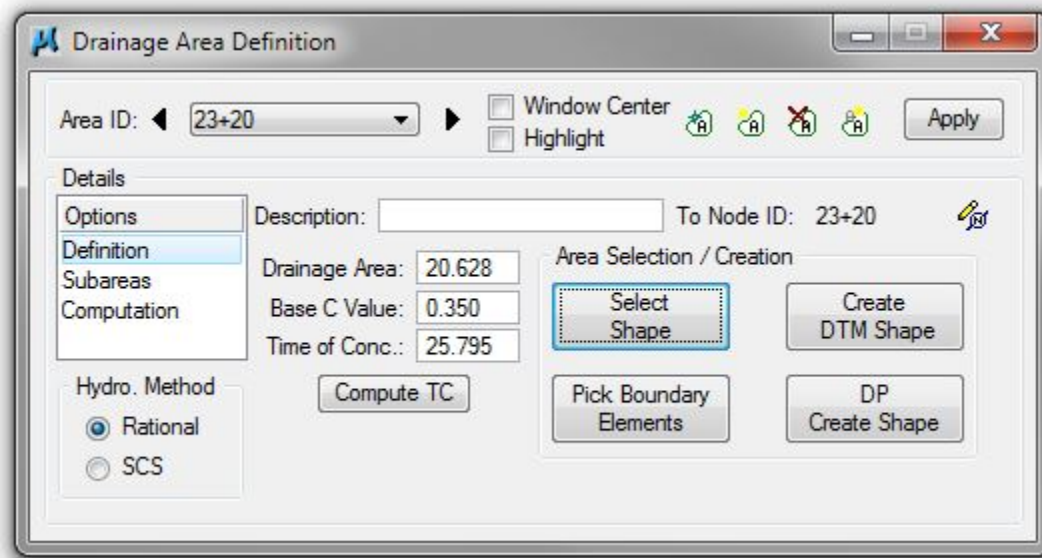
Velocity: 5.000

Accum. Distance: 2060.028

Accum. Avg. Slope: 2.320

Tc= 25.795 **Compute** Apply

The Drainage Area Definition is now filled out.



The "Drainage Area Definition" dialog box is shown. It has a title bar with a blue icon and the text "Drainage Area Definition". Below the title bar, there is a section for "Area ID" with a dropdown menu set to "23+20". To the right of this are checkboxes for "Window Center" and "Highlight", and a row of four small circular icons with letters A, C, R, and A. An "Apply" button is on the far right. Below this is a "Details" section with a vertical list of options: "Options", "Definition" (which is highlighted in blue), "Subareas", and "Computation". To the right of this list, there is a "Description:" label followed by a text box. Further right is "To Node ID: 23+20" with a small icon. Below the "Description" label are three input fields: "Drainage Area: 20.628", "Base C Value: 0.350", and "Time of Conc.: 25.795". Below these is a "Compute TC" button. To the right of the input fields is a section titled "Area Selection / Creation" containing four buttons: "Select Shape" (highlighted with a blue border), "Create DTM Shape", "Pick Boundary Elements", and "DP Create Shape". At the bottom left, there is a "Hydro. Method" section with two radio buttons: "Rational" (selected) and "SCS".

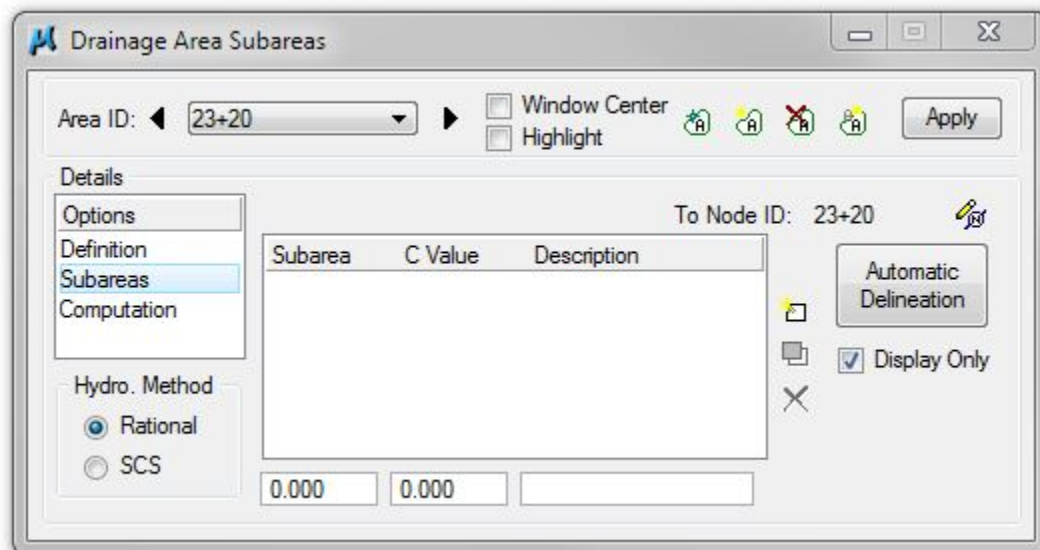
**NOTES:**

Minimum Time of Concentration is 5 minutes. If computed time is less than **5 minutes** input 5 manually.

For urban areas adjust maximum sheet flow as required.

For areas that drain directly from sheet flow to concentrated flow, uncheck the Shallow Flow box. Leaving this box checked and setting it to zero will not allow TC to be calculated correctly.

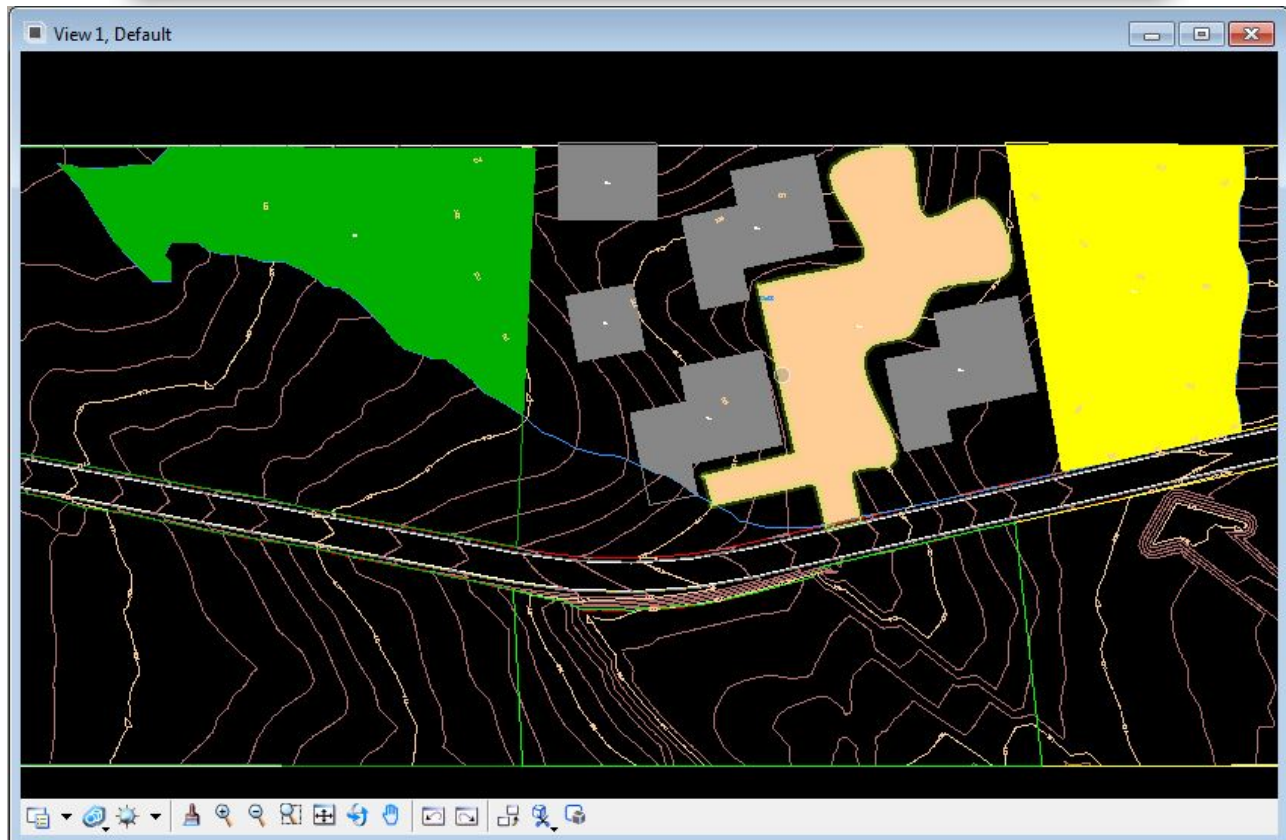
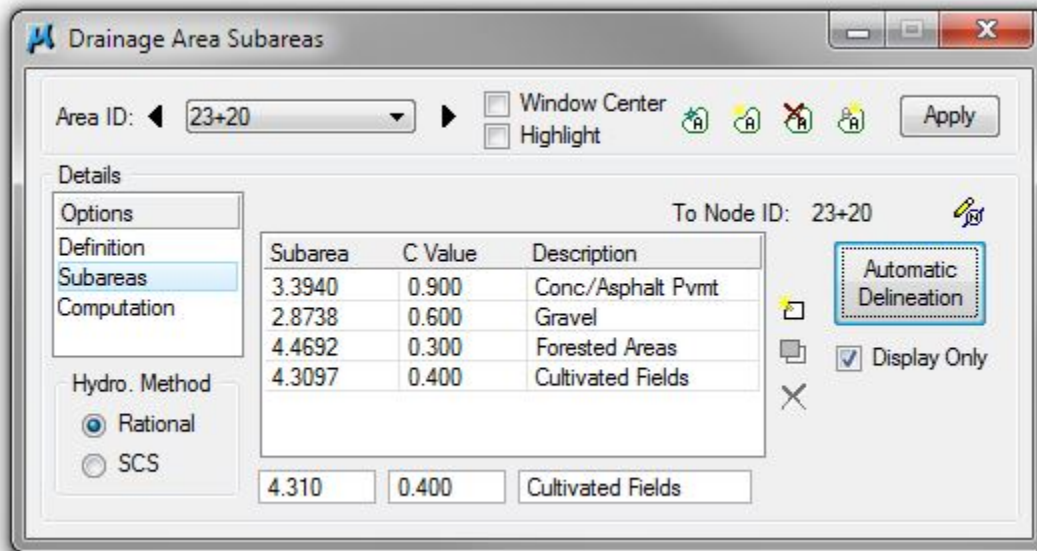
After the drainage area has been set up, runoff coefficients can be automatically computed with the use of *Land Use Items* from the Drainage Library. Click on **Subareas** in the Details list on the left.



The "Drainage Area Subareas" dialog box is shown. It has a title bar with a blue icon and the text "Drainage Area Subareas". Below the title bar, there is a section for "Area ID" with a dropdown menu set to "23+20". To the right of this are checkboxes for "Window Center" and "Highlight", and a row of four small circular icons with letters A, C, R, and A. An "Apply" button is on the far right. Below this is a "Details" section with a vertical list of options: "Options", "Definition", "Subareas" (which is highlighted in blue), and "Computation". To the right of this list, there is a "To Node ID: 23+20" label with a small icon. Below the "Details" list is a "Hydro. Method" section with two radio buttons: "Rational" (selected) and "SCS". The main area of the dialog is a table with three columns: "Subarea", "C Value", and "Description". The table is currently empty. Below the table are three input fields, the first two of which contain "0.000". To the right of the table is a section titled "Automatic Delineation" with a button labeled "Automatic Delineation" and a checkbox labeled "Display Only" which is checked. There are also some small icons (a folder, a document, and a cross) to the left of the "Automatic Delineation" section.

## Exercise 4

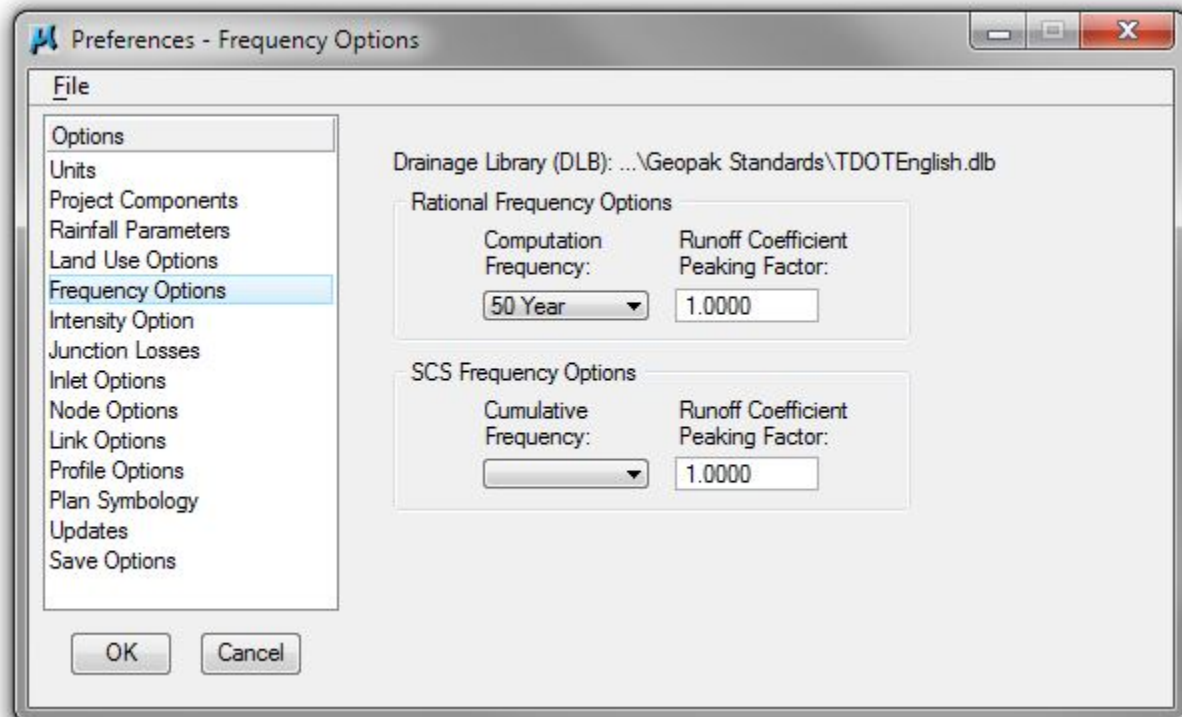
**Step 7.** Toggle ON **Display Only** and then click the **Automatic Delineation** button. The file is scanned for closed shapes matching the Land Use symbology specified in the Drainage Library (Land Use Tab).



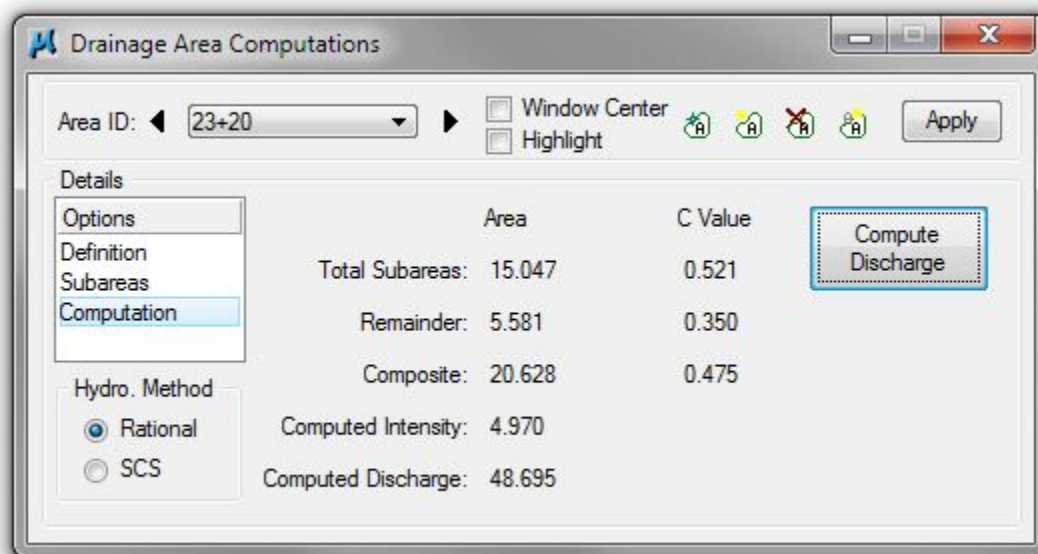
**Step 8.** Click the **Apply** button to apply the land uses (and their "C" values) to the Drainage Area.



**Step 9.** We want to compute the discharge for a 50-year storm so if that is not already set; select **Project>Preferences>Frequency Options** and change the Frequency to the 50-year storm. Click the **OK** button to accept the new preference setting.



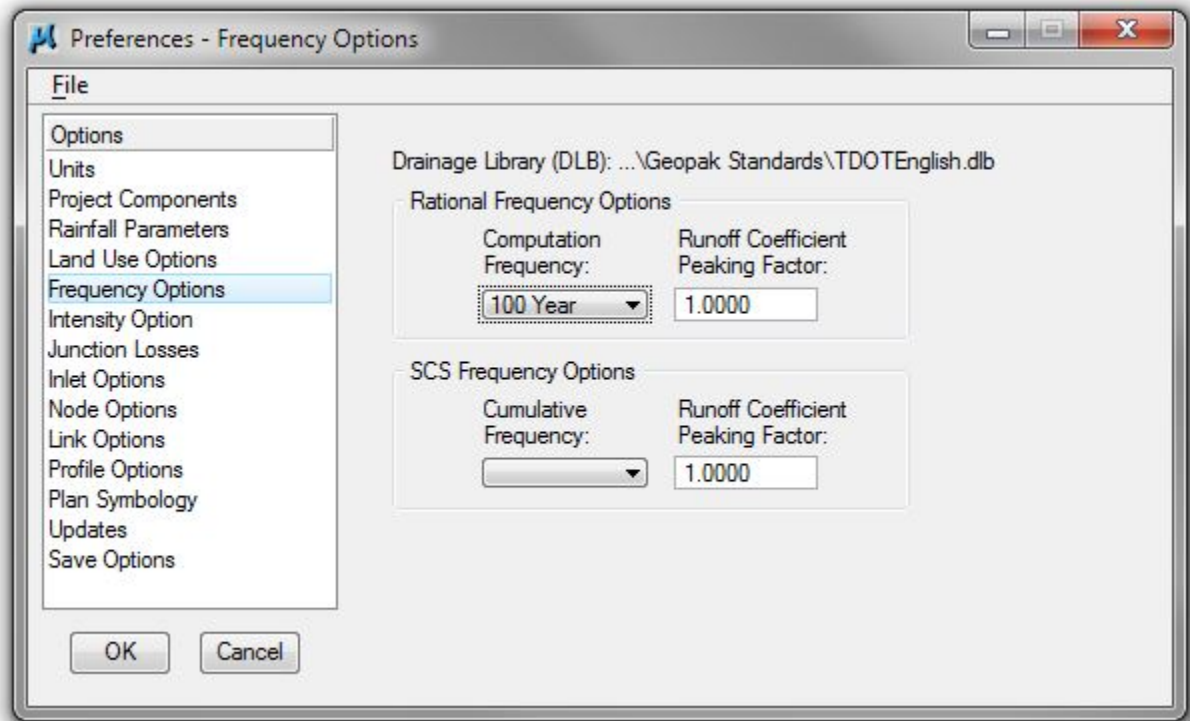
**Step 10.** Return to the **Drainage Area Computations>Computation** dialog box and click the **Compute Discharge** button:



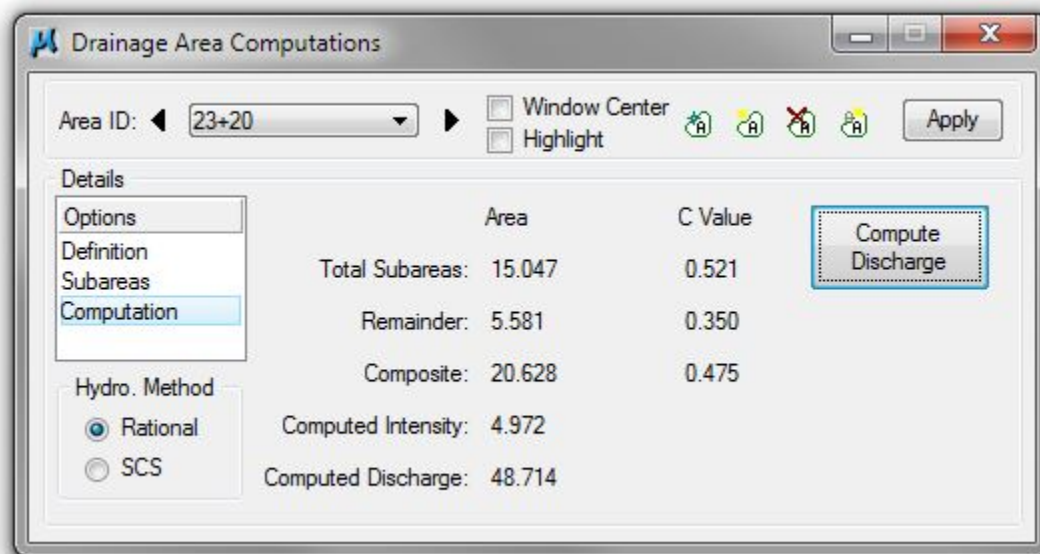
Verify the Computations; then click **Apply** to add the Area to the Project.

## Exercise 4

- Step 11.** Jot down the Computed Discharge from the 50-year storm computed in the step above here: \_\_\_\_\_
- Step 12.** Recompute the drainage area discharge for the 100 Year storm. Select **Project>Preferences>Frequency Options** and change the Frequency to the 100 year storm. Click the **OK** button to accept the new preference setting.



- Step 13.** Return to the Drainage Area Definition dialog box and click the **Compute Discharge** button:



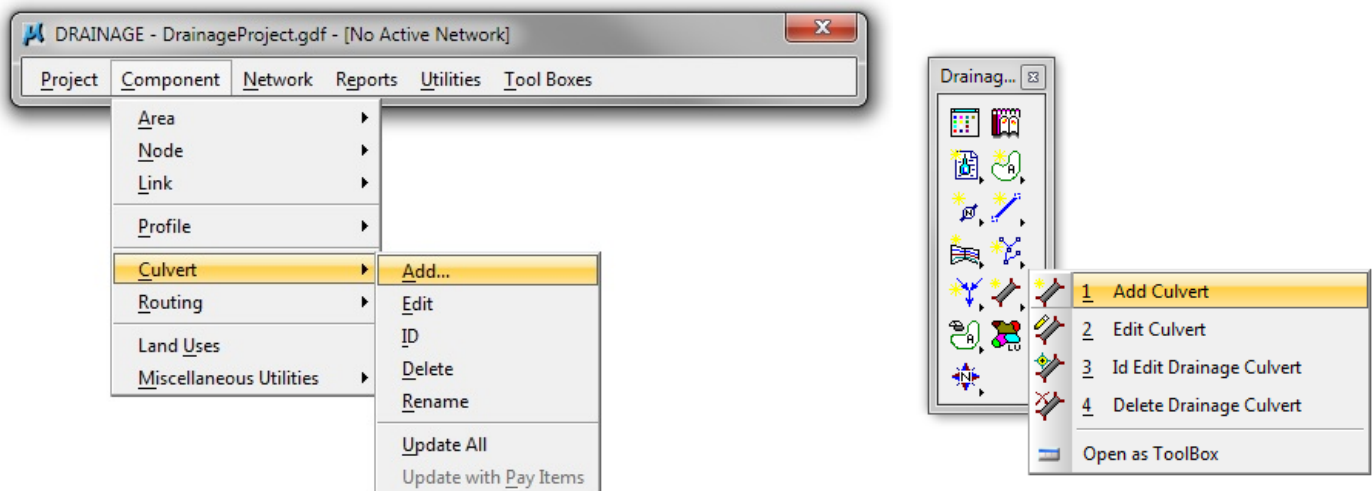
**Step 14.** Jot down the Computed Discharge from the 100-year storm computed in the step above here: \_\_\_\_\_

**Step 15.** Close the **Drainage Area Definition** dialog box.

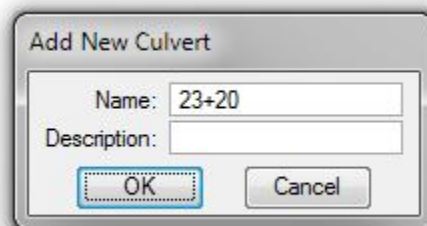
**Step 16.** Change the Frequency back to the 50 Year storm

## 4.2 Design the Culvert

**Step 1.** From the Drainage main menu, select **Component > Culvert> Add**.



**Step 2.** Click on the Add button to add a new culvert. Enter the Culvert Name as **23+20** (station of the culvert) and Click **OK**.





## Exercise 4

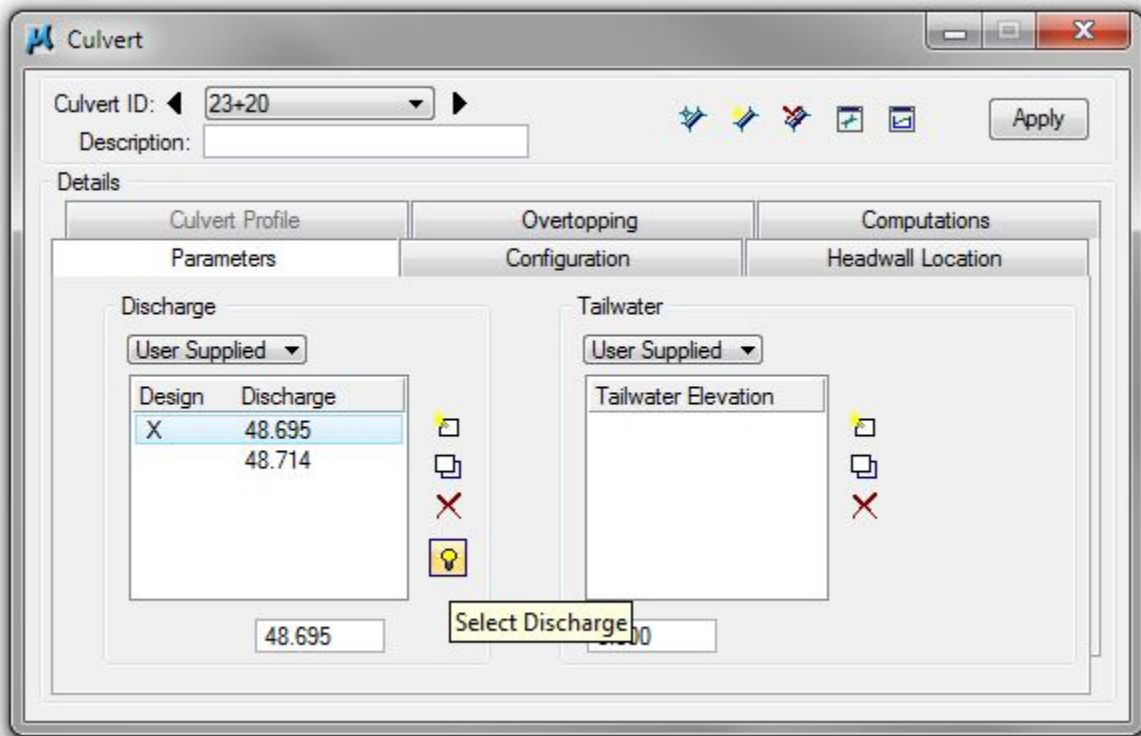
**Step 3.** The **Culvert** dialog will open as seen below:

The screenshot shows the 'Culvert' dialog box. At the top, 'Culvert ID' is set to '23+20'. Below it is a 'Description' field. The 'Details' section has three tabs: 'Culvert Profile', 'Overtopping', and 'Computations'. The 'Parameters' sub-tab is active, showing 'Discharge' and 'Tailwater' sections. Both sections have a 'User Supplied' dropdown and a table with 'Design' and 'Discharge' columns. The 'Discharge' table is empty, and the 'Tailwater' table has one row with 'Tailwater Elevation'. Both tables have a '0.000' value at the bottom. There are 'Add List Item' and 'Remove List Item' buttons next to each table.

**Step 4.** Enter the culvert discharges from Steps 11 and 14 in the previous exercise. Key-in the discharges in the key-in field and click the **Add List Item** button for each discharge

The screenshot shows the 'Culvert' dialog box with the 'Discharge' table populated with two rows: '48.695' and '48.714'. The 'Tailwater' table remains empty. The '48.714' value in the 'Discharge' table is circled in red. A tooltip labeled 'Add List Item' is visible over the 'Add List Item' button. The '0.000' value at the bottom of the 'Discharge' table is also visible.

**Step 5.** Highlight the 50-yr storm and click **Select Discharge**. This will be the Discharge that the culvert is designed for.



You could also just double **click** to set the desired Design **Discharge** that the culvert is designed for.

## Exercise 4

**Step 6.** Define the tailwater. Set the **Tailwater** option to **Compute** and key-in the slope and N Value.

### NOTES:

This slope is the longitudinal slope of the downstream channel. This slope can be determine utilizing the **Analysis** tool: **Height/Slope** located in **Applications>GEOPAK>ROAD>DTM Tools**

N Values for different surface channels are available in the TDOT Drainage Manual, Table 5A-11 *Values of Roughness*

The screenshot shows the 'Culvert' software window. At the top, 'Culvert ID' is set to '23+20'. Below it is a 'Description' field. The 'Details' section has three tabs: 'Culvert Profile', 'Overtopping', and 'Computations'. The 'Computations' tab is active, showing 'Parameters', 'Configuration', and 'Headwall Location' sub-tabs. The 'Configuration' sub-tab is selected, displaying the 'Tailwater' section. In the 'Tailwater' section, the 'Tailwater' dropdown is set to 'Compute'. The 'Slope %' is set to '0.400' and the 'N Value' is set to '0.040'. The 'Adjust Tailwater Depth' is set to '0.000'. There is an 'Extract Cross Section' button. Below these fields is a table with 'Distance' and 'Elevation' columns, currently empty. To the left of the 'Tailwater' section is a 'Discharge' section with a 'User Supplied' dropdown and a table with 'Design' and 'Discharge' columns. The table contains two rows: 'X' with '48.695' and '48.714'. There is a '48.695' input field below the table.

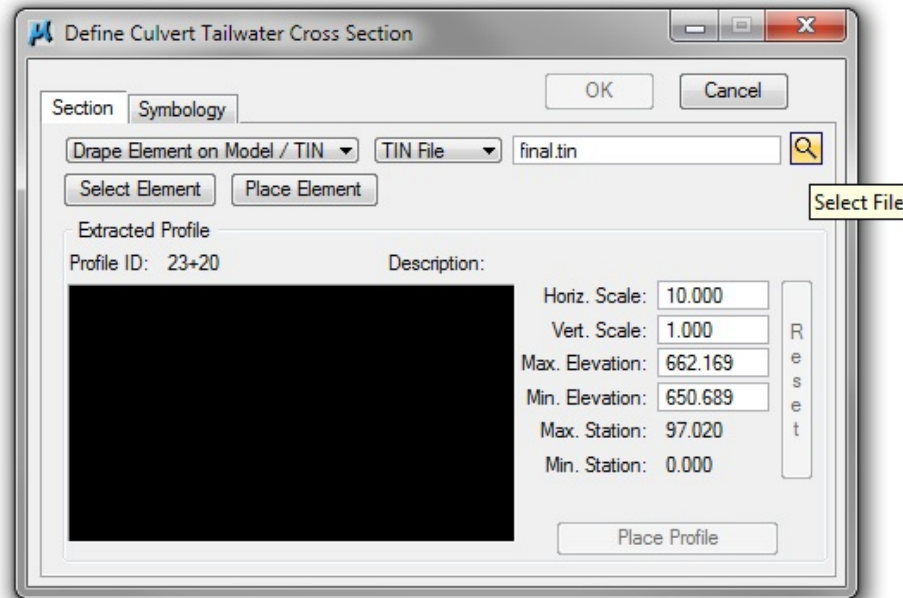
Design	Discharge
X	48.695
	48.714

Distance	Elevation
0.000	0.000

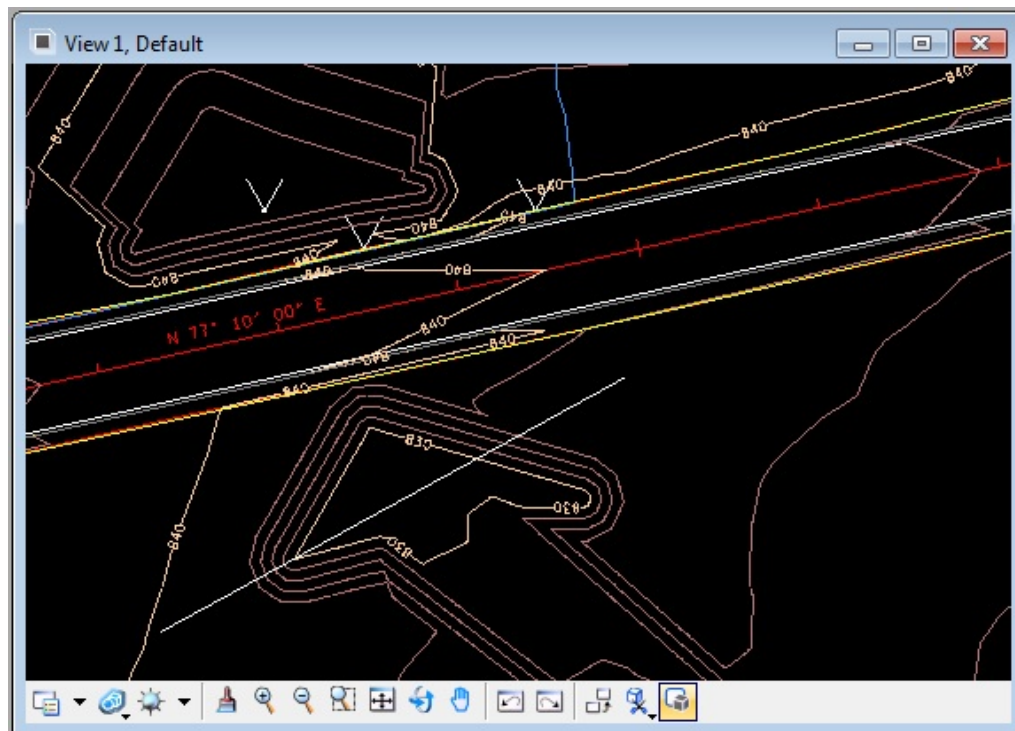
Set the **Slope %** to **0.400** and the **N Value** to **0.040** and click the **Extract Cross Section** button.

**Step 7.** The **Define Culvert Tailwater Cross Section** dialog will open. Set to **Drape Element on Model/TIN** and **TIN File**.

Click on the **Select Files** button and select **final.tin**.

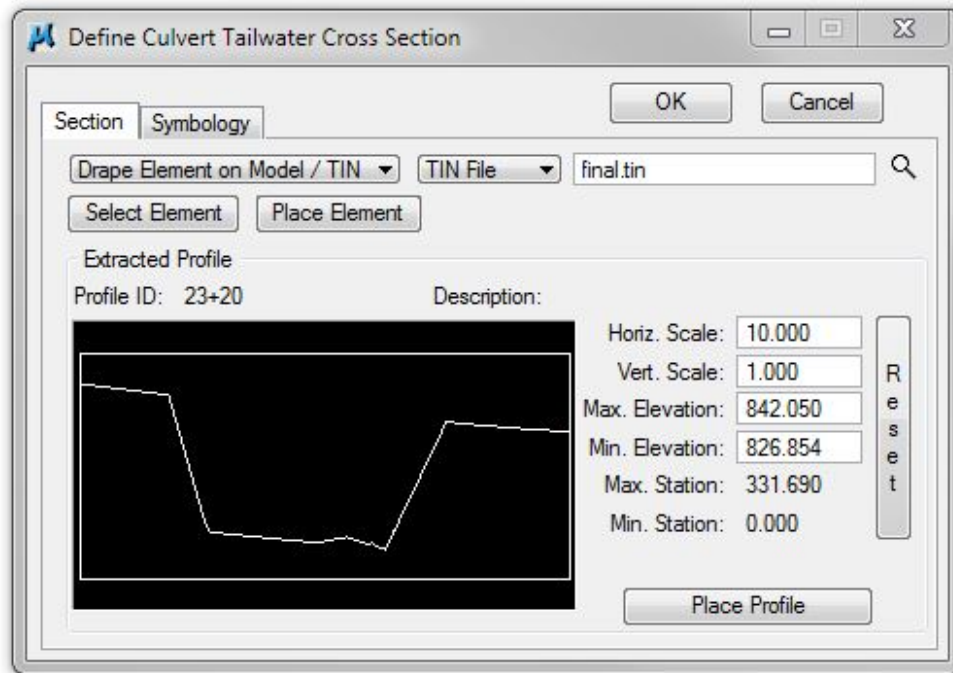


**Step 8.** Click the **Place Element** button to locate the position of the tailwater cross section that is to be extracted (this is notated as the 'Extracted Profile' on the dialog). Place a line in a location similar to that shown below:

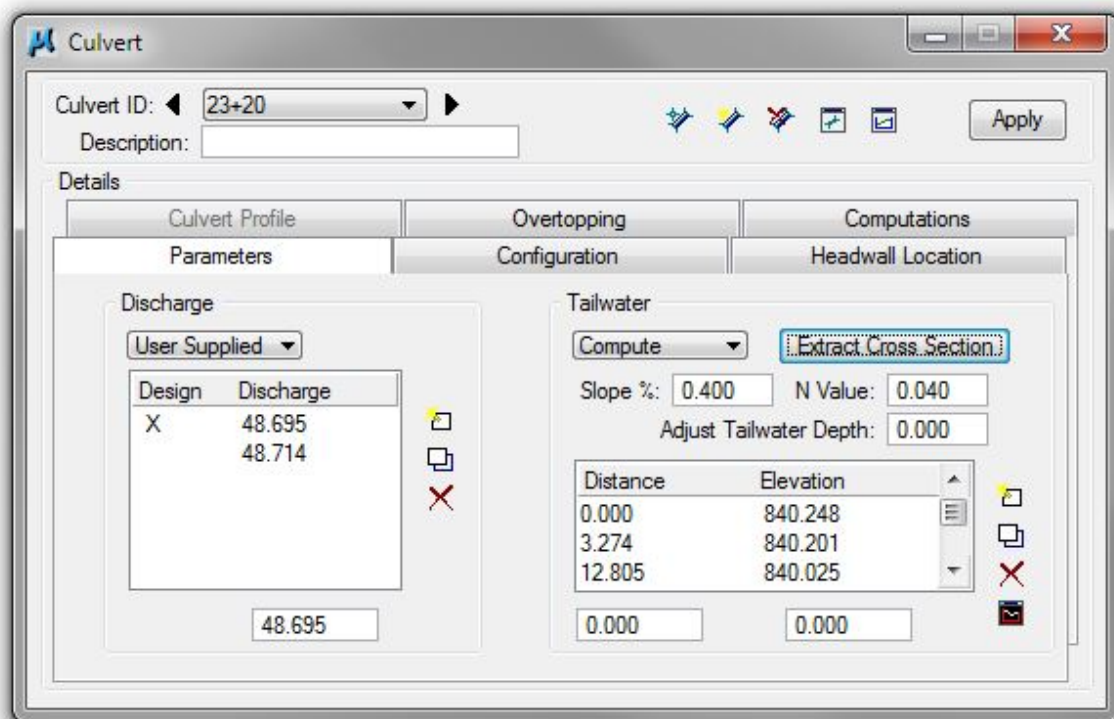


## Exercise 4

**Step 9.** The **Define Culvert Tailwater Cross Section** dialog will now contain the profile along the element placed representing the channel cross section at this location.



**Step 10.** Click the **OK** button and the main culvert dialog will open again. The values for the tailwater section will now be populated.



**Step 11.** Select the **Configuration** tab to define the type of Culvert. Make settings as listed below.

**Shape:** Circular  
(Culvert Shape: Circle, Box, Ellipse, Etc.)

**Material:** Concrete  
(Culvert Material: Concrete, Steel, Plastic, Etc.)

**Headwater Elevation:** 836.50  
(The maximum elevation the water can reach at the upstream end of the culvert).  
By default this option is set to Allowable Headwater which uses a height value, click to change to Headwater Elevation.

**Maximum Rise:** 5.000  
(The maximum diameter, height of the culvert)

**Minimum Rise:** 1.500  
(The minimum diameter, height of the culvert)

**Design Barrels:** Toggle ON  
(Allows the program to design multiple barrels, if required)

**Number of Barrels:** 1

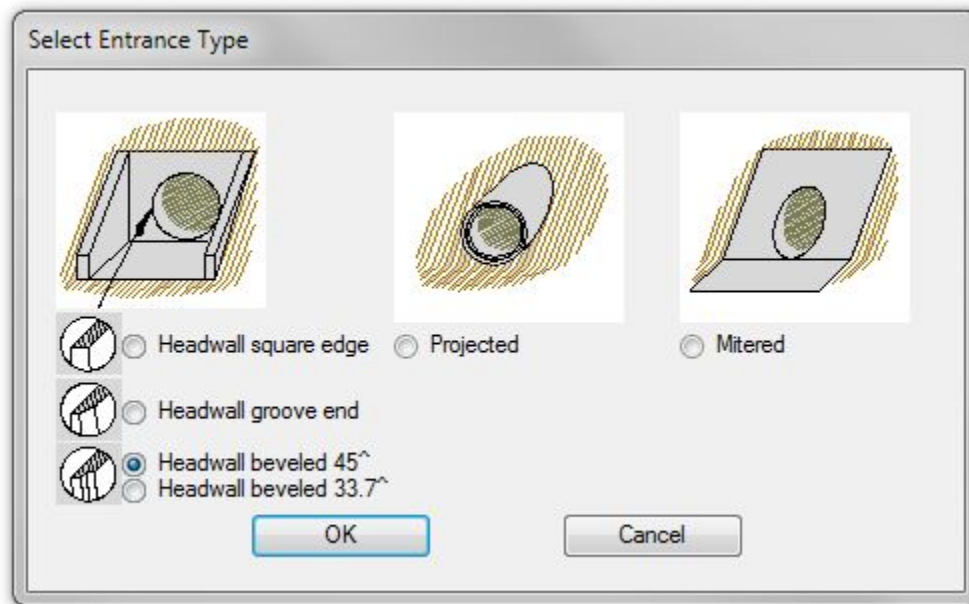
**Roughness:** 0.013  
(Determined by the type of Material, See the TDOT Drainage Manual Section 6.04.2.4.3, *Culvert Roughness Coefficients*)

**NOTE:** If you know the size of culvert you need beforehand you may set Culvert Size to 'Library Item' and pick from the list of defined items.



## Exercise 4

**Step 12.** Click **Select Entrance** and select the appropriate entrance condition. The most commonly used for TDOT projects is **Headwall beveled 45°**. Select this condition and click ok. This will automatically set the **Entrance K<sub>e</sub>** value.



**Step 13.** Select the **Headwall Location** tab to define the location of the **Upstream Headwall** and **Downstream Headwall** (nodes). Make settings as listed below.

**Type:** Plan View

**Reference Chain:** CL  
(Roadway Centerline)

**TIN File:** final.tin

**Library Item:** Culvert Endwall

**Alignment:** Tangent to Ref. Chain

**+ Angle.:** 0 or 180

(For headwalls parallel to the roadway on the right side use an angle adjustment of 180 and on the left use 0. In this case the upstream is on left so that value should be set to 0.)

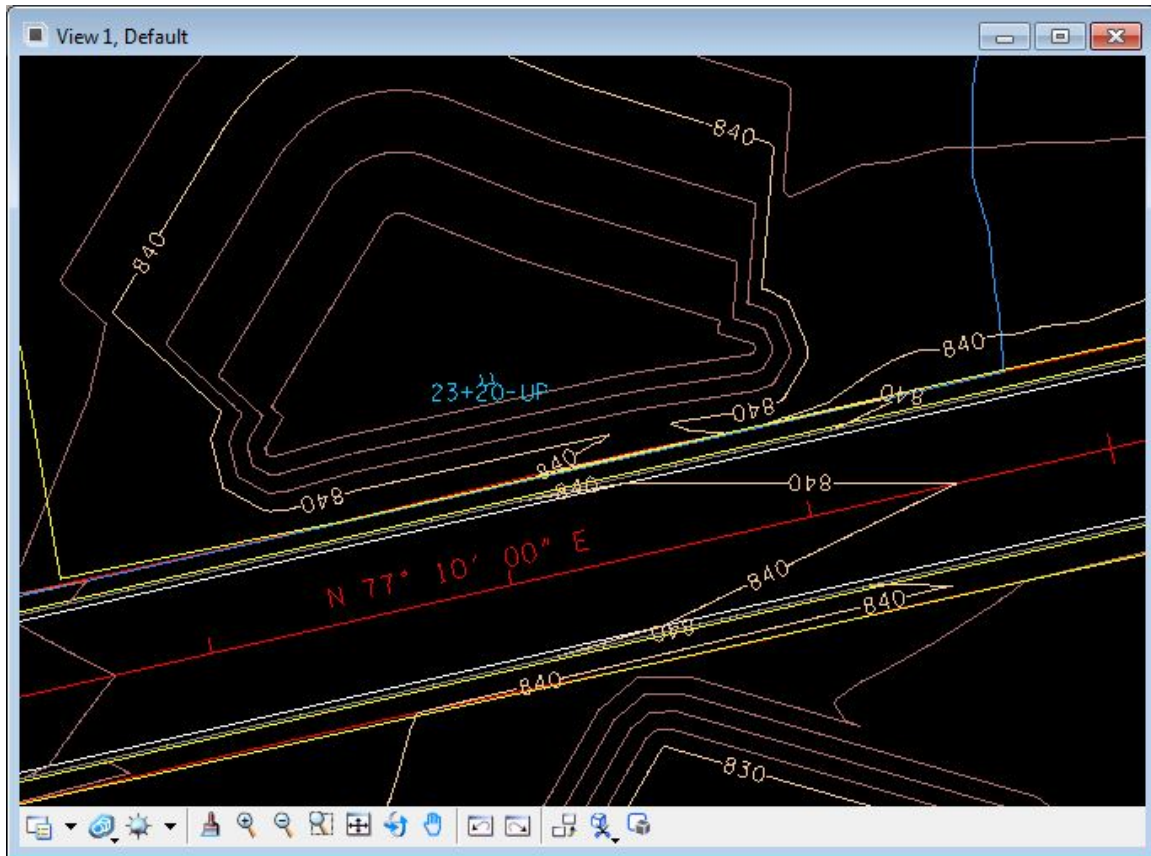
**NOTE:** Another option is to use Mirror Cell. Set angles to 0 and Toggle ON for headwalls on the right of the roadway and Toggle Off for headwalls on the left of the roadway. Do **NOT** use Mirror Cell along with Angle Rotations as this adds confusion.

**Invert Elev.:** TIN / Model

(Reads TIN elevations. Use 'User Supplied' inverts are known or are different than TIN file.)

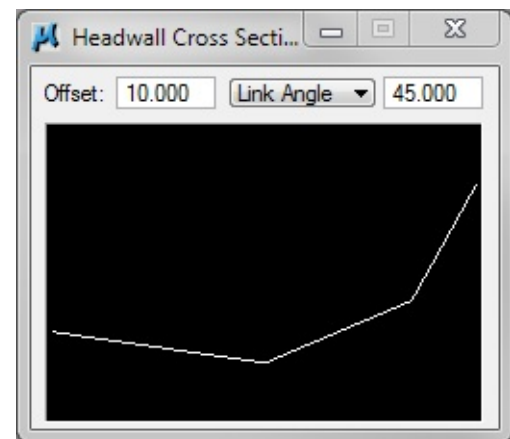
## Exercise 4

**Step 14.** Locate the **Upstream Headwall** by clicking the **Dynamic Place** button and setting the upstream headwall at a location similar to that shown below:



Watch the **Headwall Cross Section** dialog box appear upon mouse-movement. Use this viewer to place the Headwall at the upstream **low point**.

Station and offset values for the headwall location should change dynamically in the dialog as you move your mouse. If not, reset the chain name and try **Dynamic Place** again. It may be necessary to close the tool and reopen.

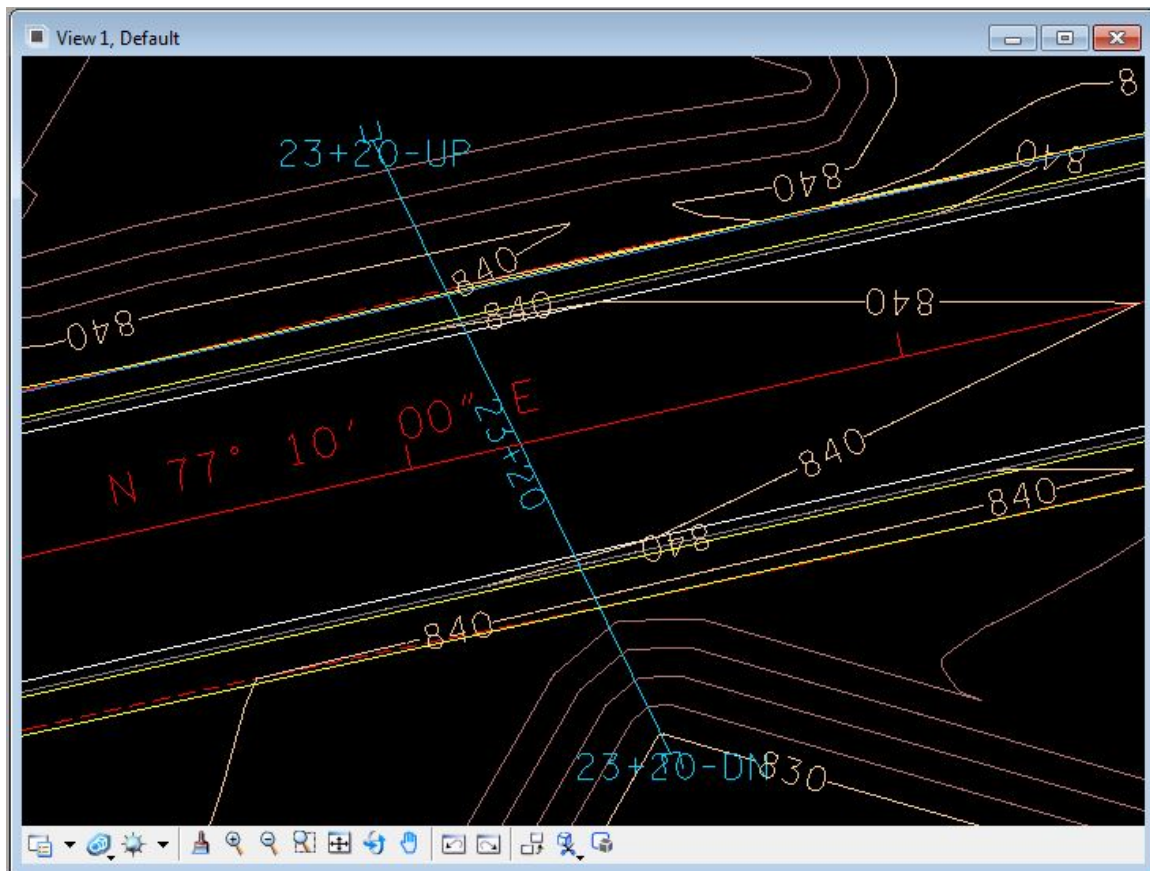


### NOTES:

To set the headwall locations for 90 degree crss drains, you can enter the centerline crossing station with a given offset and click the Keyin Place button.

You may wish to utilize the **DTM Tools>Low Point Tool** (as discussed in the DTM Tools Section 3 in order to predetermine the low point locations.

**Step 15.** Locate the downstream headwall by clicking **Dynamic Place** under the **Downstream Headwall** group.



## Exercise 4

**Step 16.** Select the **Overtopping** tab to define the limits of roadway overtopping. Make settings as listed below and click **Extract PGL Profile**.

**NOTE:** This step is only necessary if your culvert is in a **sag** condition. If you are not in a sag condition you may proceed to **Step 17**.

The screenshot shows the 'Culvert' software window. At the top, 'Culvert ID' is set to '23+20'. Below it is a 'Description' field. The 'Details' section has three tabs: 'Parameters', 'Configuration', and 'Headwall Location'. The 'Configuration' tab is active, showing 'Culvert Profile', 'Overtopping', and 'Computations' sub-tabs. The 'Overtopping' sub-tab is selected. It contains the following settings: 'Overtopping Source' is 'PGL', 'Adjust Constant Delta Elevation' is '0.000', 'Width' is '48.000', 'Pavement' is checked, 'Reference Chain' is 'CL', 'Ref. PGL' is 'DESIGNCL', 'Begin Station' is '22+00.00', 'End Station' is '25+00.00', and 'X Increment' is '5.000'. There are 'DP' buttons next to the stationing fields. A table with 'Distance' and 'Elevation' headers is visible, with '0.000' values at the bottom. An 'Extract PGL Profile' button is also present.

**Overtopping Source: PGL**

(This option sets the roadway profile as the controlling surface elevation for overtopping. Other options include 'User Supplied' or constant elevation and 'DTM')

**Width: 48.00**

(This is the width of your roadway)

**Pavement: Toggle ON**

(This should be checked unless your road is not paved)

**Reference Chain: CL**

(Roadway Centerline)

**Ref. PGL: DESIGNCL**

(Roadway Profile)

**Begin Station: 22+00.00**

(Use the **DP** button to select a point before the culvert.)

**End Station: 25+00.00**

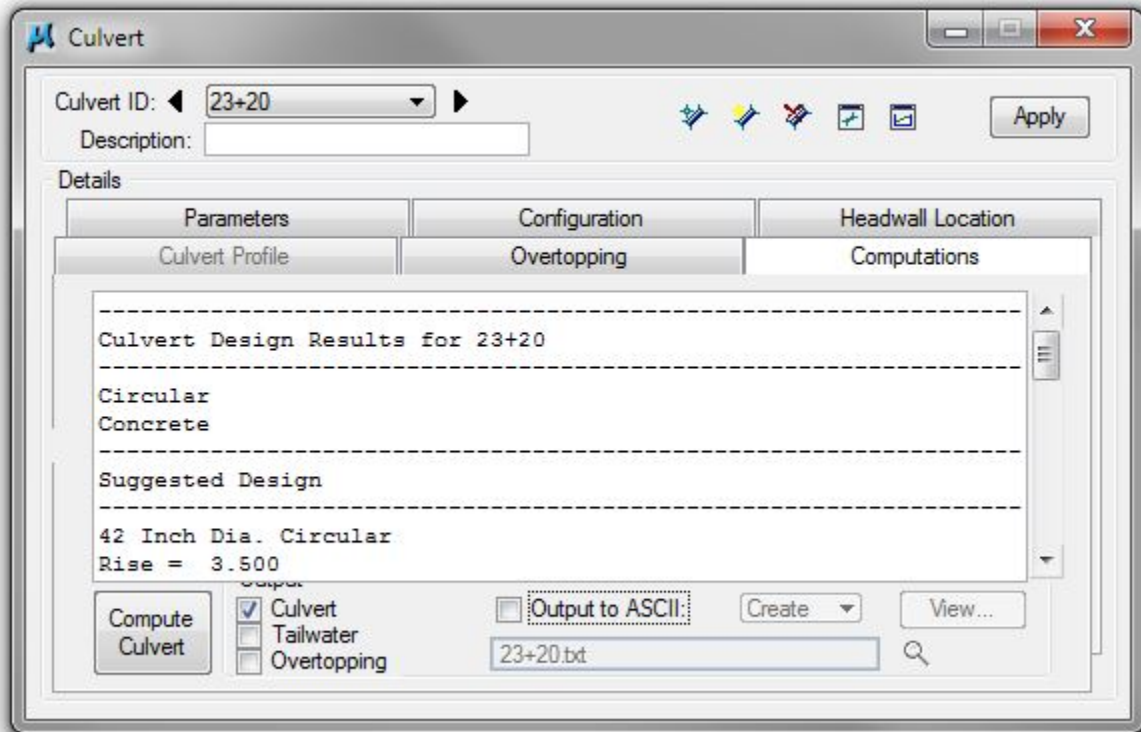
(Use the **DP** button to select a point after the Culvert.)

**X Increment: 5.000**

(This may be automatically adjusted depending on the distance between the begin station and end station.)



- Step 17.** Once the Nodes have been located, and the elevations appropriately calculated, the Culvert can be added to the project. Click the **Apply** button and the culvert will be drawn and labeled according to the symbology in the Preferences.
- Step 18.** The information to this point is enough to check the culvert computations. Select the **Computations** tab. Toggle on the option to view the **Culvert** calculations. Click the **Compute Culvert** button to perform the calculations.



**NOTE:** You may include Tailwater and Overtopping calculations (if you need them) by toggling ON the option to view them.

## Exercise 4

At this point, the designer has the pipe size that will be required and can use regular Geopak proposed cross section tools to set up a culvert section to finalize the length & inverts for the cross drain.

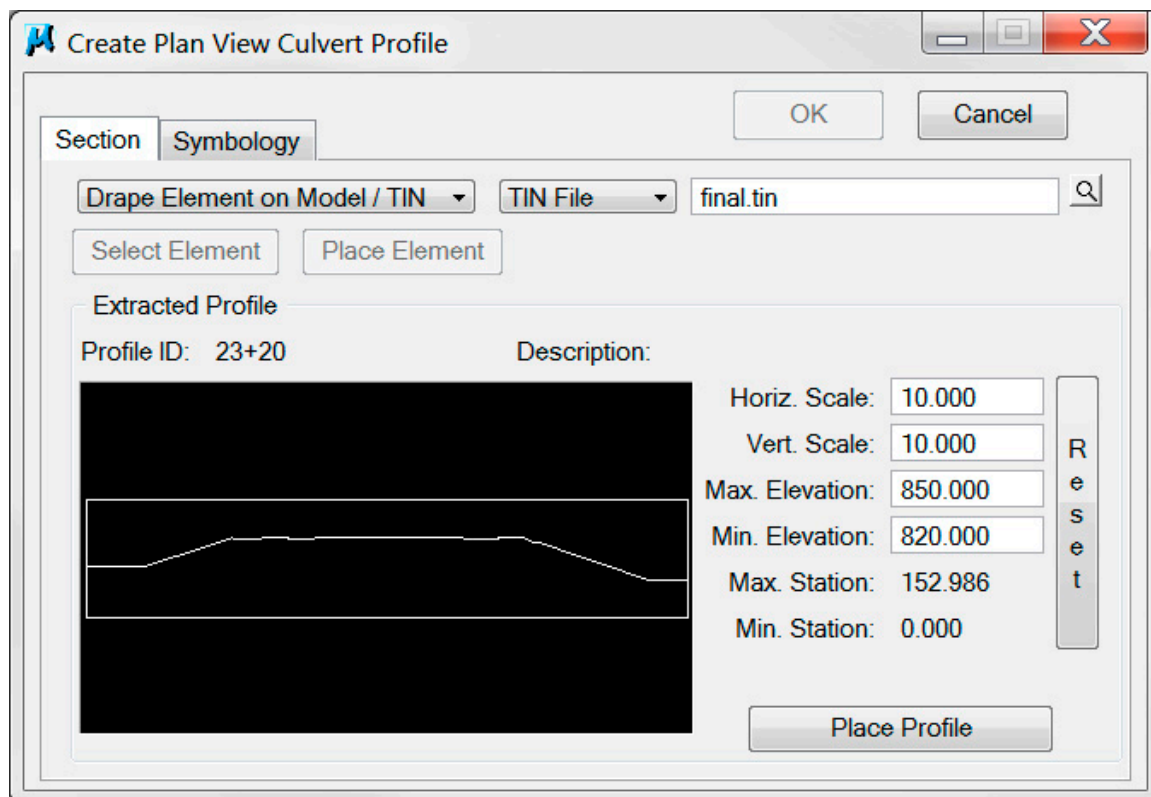
The next several steps illustrate the functionality available through Geopak Drainage to set up a culvert section in profile format along the cross drain.

**Step 19.** On the **Headwall Location** tab click on **Create Profile** to set up a culvert section and finalize headwall locations. The **Create Plan View Culvert Profile** dialog will open up. Make settings as shown below.

Set **Horiz scale 10** and **Vert scale 10**.

Change **max** and **min** elevations to be the next even 10' up or down.

Use default values for Max and Min station.



**Step 20.** Click on the **Symbology** tab and make the following settings:

**Ground Line Symbology** (Proposed Roadway):

LV= DESIGN - TYPICAL - Finished Grade and  
Subgrade  
CO= 6, Style=0, WT=4

**Boundary Symbology:**

LV= DESIGN – SHEET – Light Grid  
CO=2, Style=0, WT=4

**Vertical Grid Major Interval:**

ON, Value=10

**Vertical Grid Minor Interval:**

OFF

**Vertical Grid Major Symbology:**

LV= DESIGN – SHEET – Light Grid  
CO=0, Style=1, WT=1

**Vertical Major Text:**

LV= DESIGN – SHEET – Corner Text  
CO=6, WT=10, TH=2, TW=2, FT=LEROYMON(3)  
Click the Top Center to set Justification

**Horizontal Grid Major Interval:**

ON, Value=10

**Horizontal Grid Minor interval:**

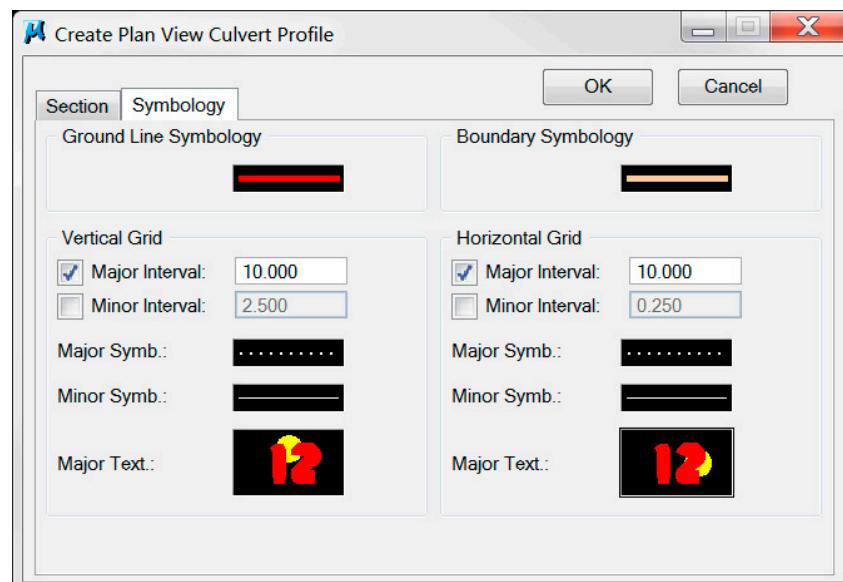
OFF

**Horizontal Grid major symbology:**

LV= DESIGN – SHEET – Light Grid  
CO=0 Style=1 WT=1

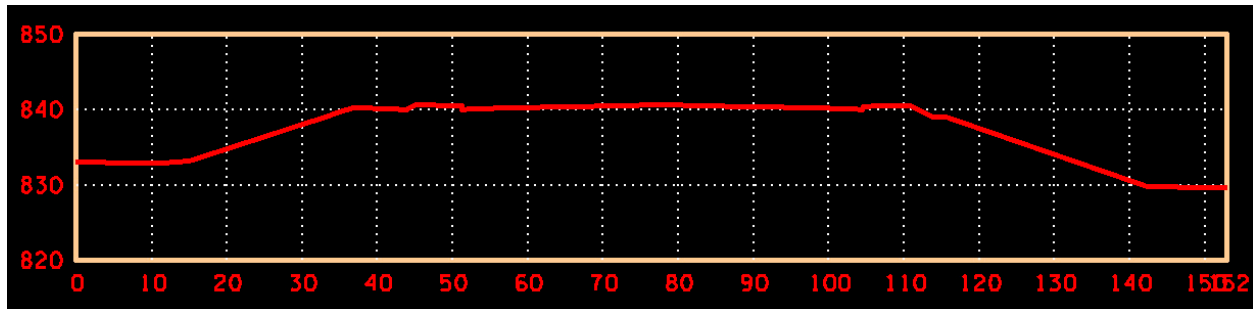
**Horizontal Major Text:**

LV= DESIGN – SHEET – Corner Text  
CO=6, WT=10, TH=2, TW=2, FT=LEROYMON(3)  
Click the Middle Right to set Justification

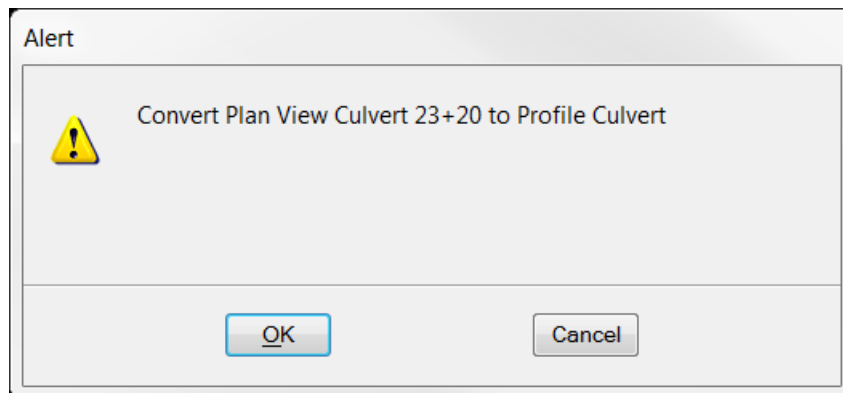


## Exercise 4

**Step 21.** Once symbologies are set click on the **Section** tab and click on **Place Profile** in the lower right of the dialog. Culvert Section graphics will appear on the cursor, Data Point out in the open somewhere to place the graphics. Click **OK** on **Create Plan View Culvert Profile** dialog to dismiss and reopen the **Culvert Edit** dialog. Click **Apply** to store the culvert information.




**Step 22.** Now that we have placed our culvert section we can finalize or inlet and outlet locations. On the **Headwall Location** tab change **Type** from Plan View setting to **Profile View**. When prompted to "Convert Plan View Culvert to Profile Culvert" click **OK**:



**Step 23.** The **Headwall location** tab will change to show Profile view controls.

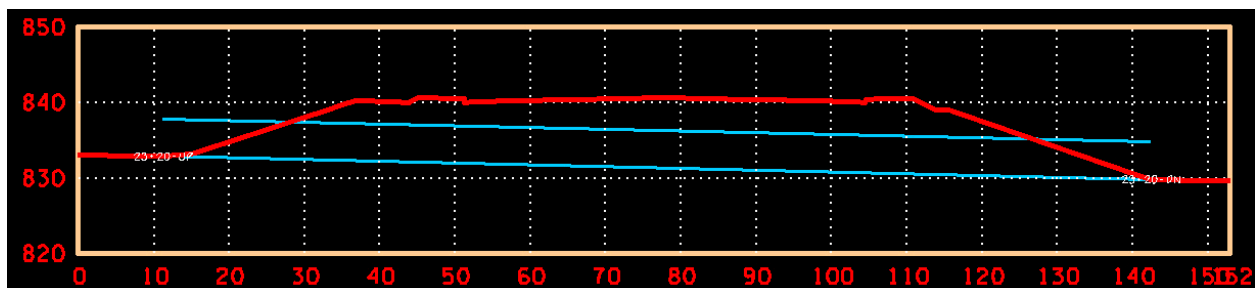
The screenshot shows the 'Culvert' software window with the 'Headwall Location' tab selected. The 'Culvert ID' is set to '23+20'. The 'Details' section is divided into three tabs: 'Culvert Profile', 'Overtopping', and 'Computations'. The 'Headwall Location' sub-tab is active, showing parameters for both 'Upstream Headwall' and 'Downstream Headwall'.

Parameter	Upstream Headwall	Downstream Headwall
Type	Profile View	Profile View
TIN File	final.tin	final.tin
Reference Chain	CL	CL
Node ID	23+20-UP	23+20-DN
Library Item	Culvert Endwall	Culvert Endwall
Drape Angle	295.2613	295.2613
+ Angle	257.572	77.572
Invert Sta.	12.190	145.643
Invert Elev.	832.901	829.669
Chain Sta.	23+08.46	23+37.18
Chain Offset	-64.206	66.120

**Step 24.** Under **Upstream Headwall** controls click **Station DP** button.  Move cursor over culvert section profile near the upstream end of pipe. That end will start dynamically tracking with cursor movement. Relocate inlet so that the upstream invert of the pipe coincides with roadway side slope.

**NOTE:** This location could be located previously with Microstation commands or calculated and input as values in the Invert Sta. & Invert Elev. Keyin fields.

**Step 25.** Repeat this procedure on the **Downstream Headwall** by clicking on **Station DP** and locating in culvert section profile.





## Exercise 4

**Step 26.** Once Headwall locations have been reset click on **Apply** in the upper right corner of the **Culvert Edit** dialog. Now go back to the **Computation** tab and this time before clicking on **Compute Culvert**, toggle ON option for **Output to ASCII**, keyin name **23+20.txt** and set file to **Create** option.

When **Compute Culvert** is clicked the output data in dialog is updated and text output file is created.

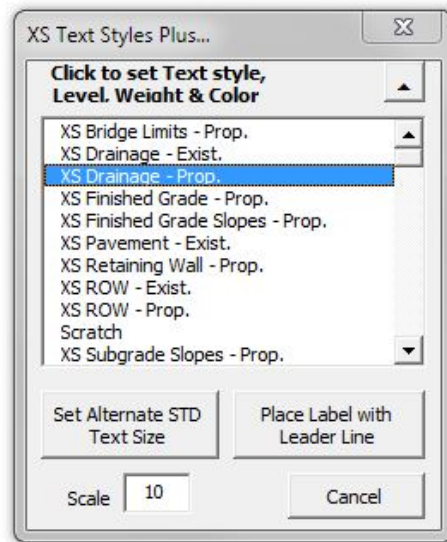
The screenshot shows the 'Culvert' dialog box with the 'Computation' tab selected. The 'Culvert ID' is set to '23+20'. The 'Description' field is empty. The 'Details' section has three tabs: 'Parameters', 'Configuration', and 'Headwall Location'. The 'Computation' sub-tab is active, displaying the following text:

```
Culvert Design Results for 23+20
-----
Circular
Concrete
-----
Suggested Design
-----
42 Inch Dia. Circular
Rise = 3.500
```

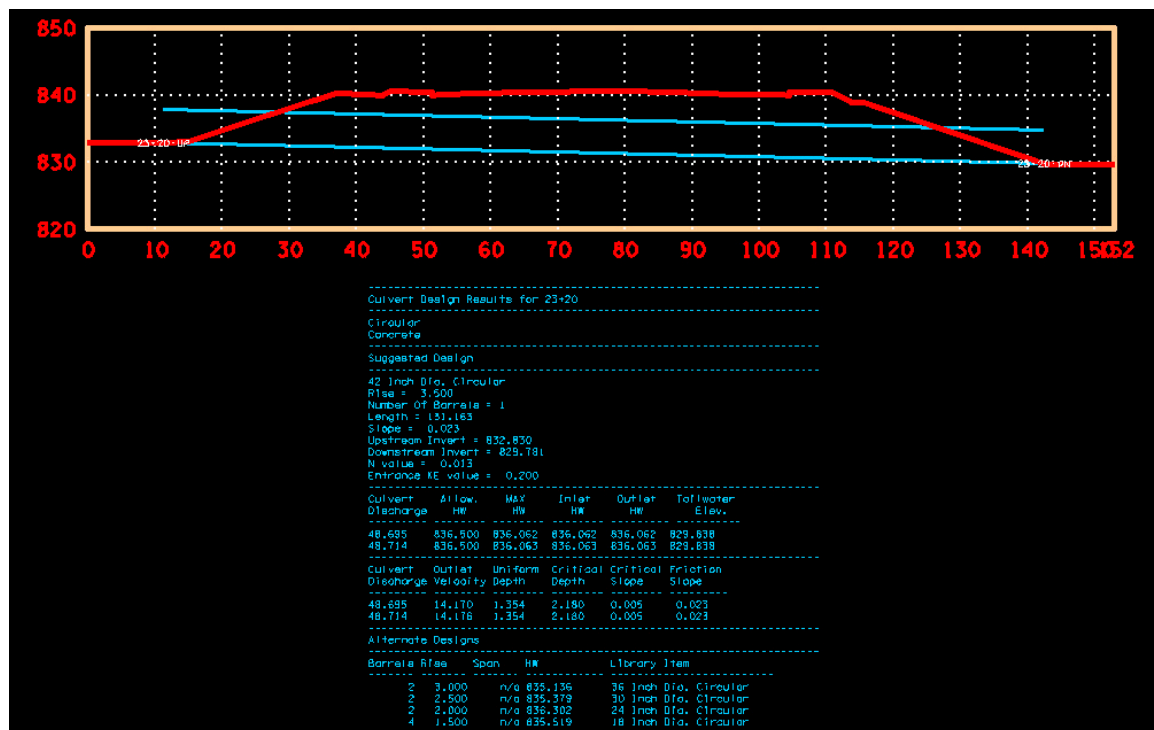
At the bottom, the 'Output' section has a 'Compute Culvert' button and three checkboxes: 'Culvert' (checked), 'Tailwater' (unchecked), and 'Overtopping' (unchecked). The 'Output to ASCII' checkbox is also checked, with a 'Create' dropdown menu and a 'View...' button. The file name '23+20.txt' is entered in the adjacent text field.

**Step 27.** To place drainage info with culvert section profile :

Set active text settings by going to **TDOT>Cross Sections>XS Text Styles Plus**, set Scale to **10** and select **XS Drainage - Prop.**:



Go to Microstation's **File>Import>Text** and pick the file **23+20.txt** in your project directory. Data Point in the DGN file for placement near the culvert section profile. This data can now be used when filling out TDOT Standard Drainage Data cells or can be edited to show additional data needed with the culvert section.



## Storm Drainage Nodes

This exercise shows the user how to create surface drainage components for storm drainage. The user will add drainage areas, inlets, and outlets as necessary for proper roadway drainage design.

Typically, each segment of the roadway drainage system will have an outlet to a side ditch, natural river or stream, or an adjacent storm drainage system. Possibilities of these outlets should be considered when determining catch basin locations.

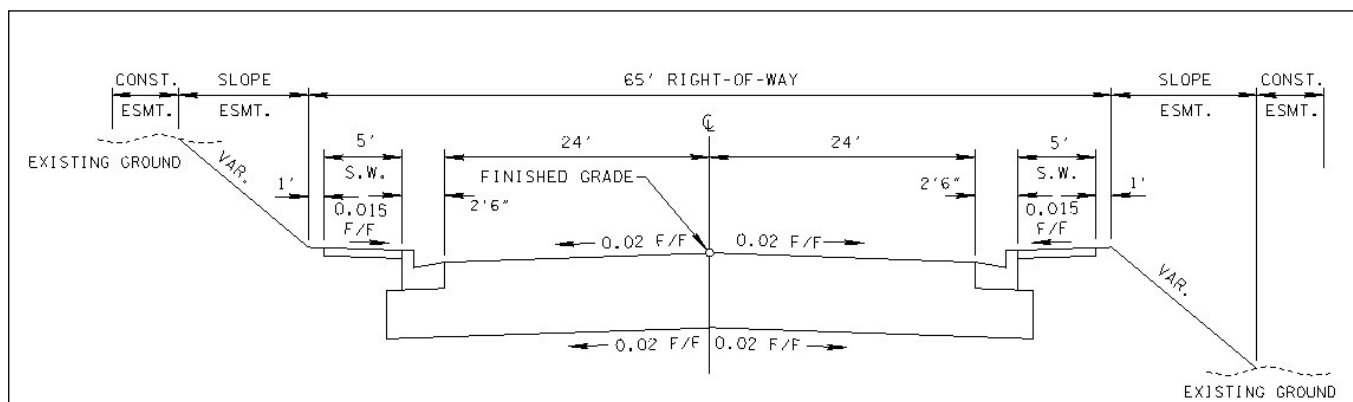
Initial locations for catch basins (inlets) should be based on the following criteria:

- 1.) At all low points (sag points) in the gutter grade or low points behind curbs, shoulders or sidewalks
- 2.) At the location down grade from the highpoint of a vertical curve where the spread is equal to the allowable spread
- 3.) At areas where off-site flow will flow across the top of curbs
- 4.) Upstream of median breaks, entrance/exit ramp gores, cross walks, street intersections, and bridges
- 5.) At side streets upgrade from the intersection
- 6.) At least every 400 feet (required for maintenance)

Once these primary locations are determined, adjustments or additions can be made to ensure that a safe travel way is maintained.

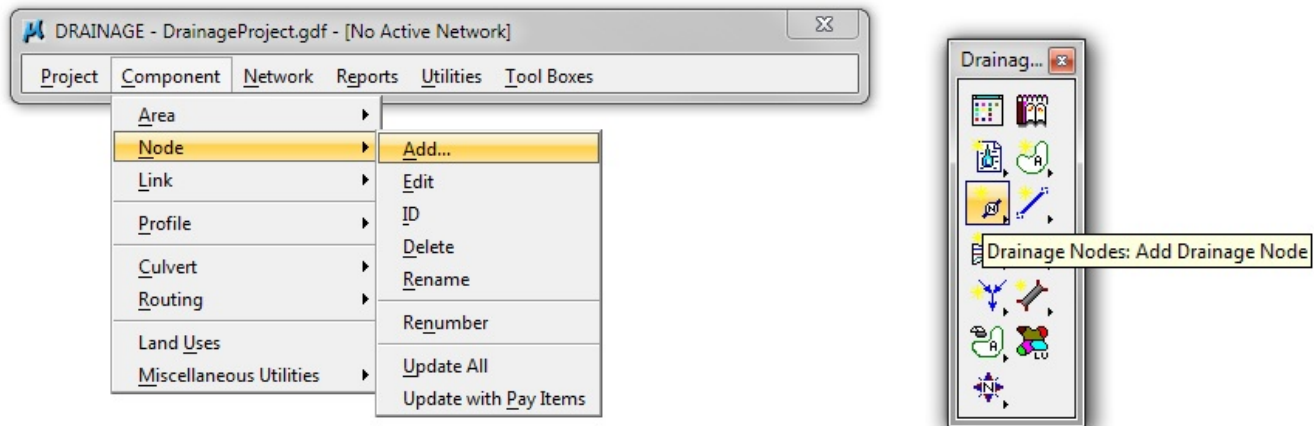
### 5.1 Design Drainage Node CB – 1

- Step 1.** Determine the location of the Proposed Inlet. The proposed roadway is 4 lanes with no shoulders and a 6" non-mountable curb with curb and grate inlets.

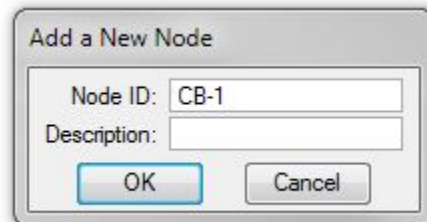


We will assume for this project that the curb and gutter begins at 0+00.00. We have also determined that our maximum allowable spread is 8.0 feet (See [TDOT Drainage Manual Chapter 7](#) Section 7.03.3.7). Using sound engineering judgment we will assume our first inlet to be at Station **4+00.00** Offset **-26.00**.

**Step 2.** From the Drainage Main Menu Bar, select **Component > Node > Add** OR from the Main Toolbar, select **Add Drainage Node**.



**Step 3.** Type in **CB-1** for the node ID. Leave the Description blank. Click OK. Over the next several steps, we will progress through the Node Configuration until everything has been set successfully.



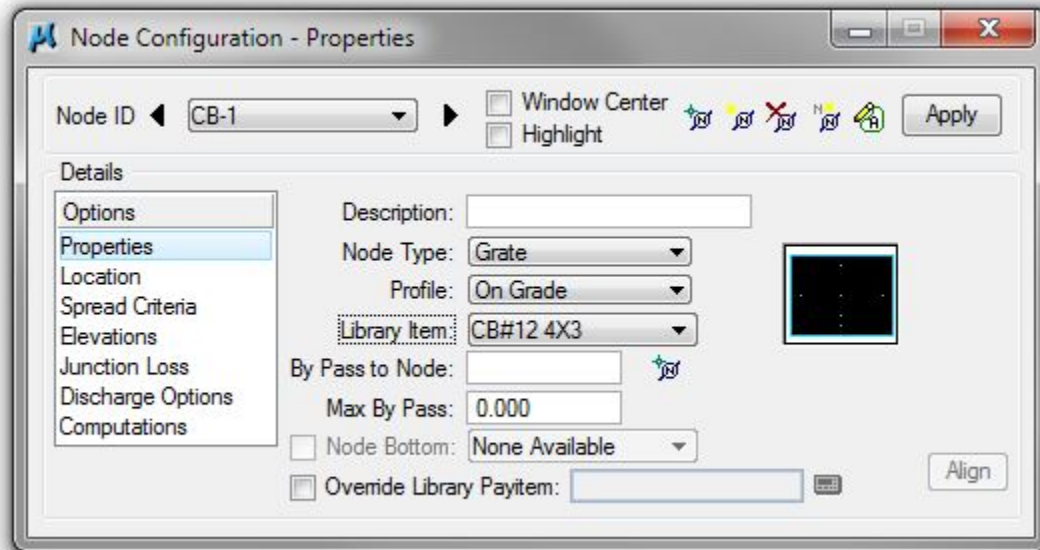
## Exercise 5

**Step 4. Properties** > With the Node Id set to CB-1, set the properties as shown below:

**Node Type:** Grate

**Profile:** On Grade

**Library Item:** CB #12 4X3



**NOTE:** This project calls for a 6" nonmountable curb and gutter inlet. A type 12 catch basin is used since it is the most common for this type of gutter. The 4X3 is chosen because it requires the least amount of depth for the type 12's. It is common practice to choose the smallest catch basin at the beginning of the system. Refer to the TDOT GEOPAK Drainage Nodes shown in Appendix A to see other sizes and types of nodes.



**Step 5. Location >** Describe the inlet's location in the design file as shown below:

**Reference Chain:** CL

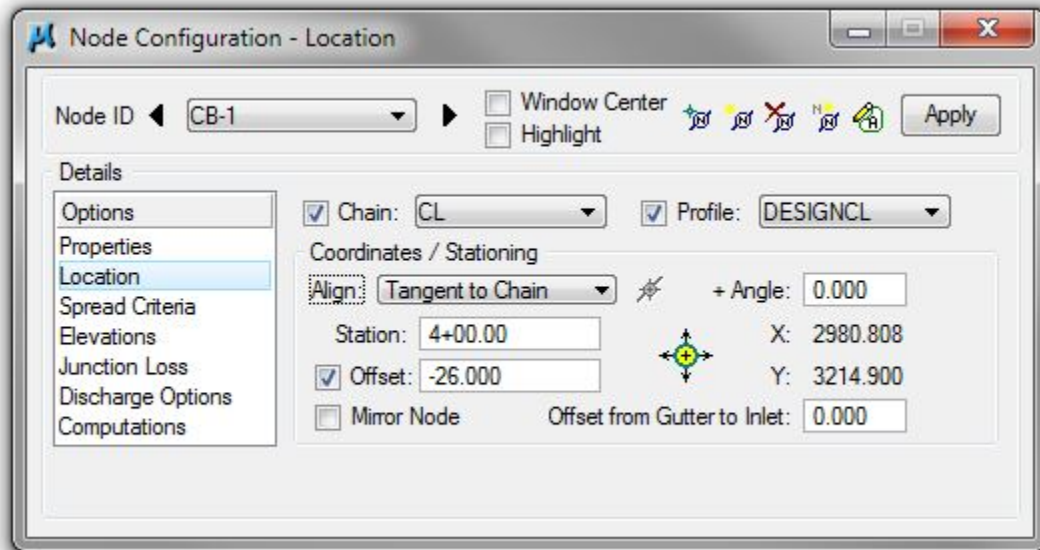
**Angle:** 0.00

**Profile:** DESIGNCL

**Station:** 4+00.00


**Align:** Tangent to Chain

**Offset:** -26.00



**NOTES:**

Once the location options are set, hit enter on your keyboard or data in one of the fields to add the catch basin. The angle of the catch basin is automatically set to match the centerline.

If a line or some other MicroStation element is located at the desired station and offset, the **Station DP**  button can be used. If Station DP is active and the location is set, **DO NOT** move out of the dialog because the station range will change. Hit enter on your keyboard or data in one of the fields to add the catch basin.

**Other Align Options:**

**Tangent to Chain:** Allows independent station and offset while matching a specified chain's angle.

**Tangent to Element:** Allows independent station and offset while matching an elements angle.

**Tangent on Element:** Allows independent station (within limits of the element) while matching elements offset and angle. (Mirror Node is often required when using this option)

**At Point:** Allows independent station, offset and angle.

## Exercise 5

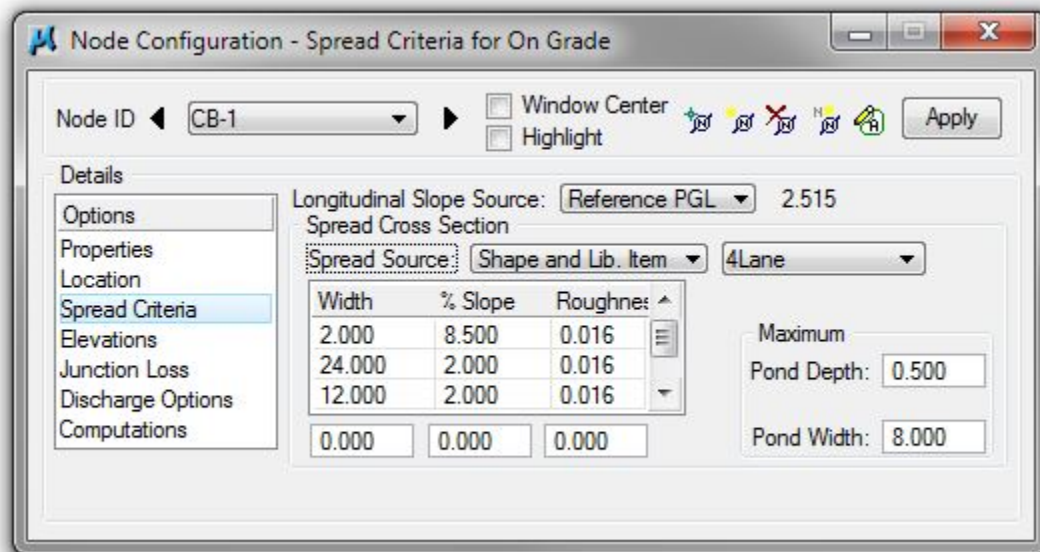
**Step 6. Spread Criteria >** Describe the roadway cross sectional characteristics directly in front of the inlet. These values will be utilized to calculate inlet capacity and resulting by-pass flow. Turn ON the display for the reference file: **DVSR1SEshapes.dgn** and choose the following options:

**Longitudinal Slope Source:** Reference PGL

**Spread Source:** Shape & Lib. Item - 4Lane

**Max Pond Depth:** 0.50 feet

**Max Pond Width:** 8.00 feet



Change **Spread Source** back to User Supplied to remove extra links created by the combination of the Shape and Library Item. The 24' link is defined in the library item but is not required since we have superelevation shapes for the pavement area

**Step 7. Spread Criteria >** In the previous step, we set the spread section using a combination of the project's superelevation shapes and a standard drainage library spread section to illustrate that if a final TIN file has not yet been made, other methods could be used. The recommended method is to use a final TIN file which should represent the roadway accurately at any given inlet location.

Change the **Spread Source** to Reference TIN.

**Step 8. Elevation** > Assign the inlet vertical elevation and vertical pipe alignment options. The **Reference Surface: Tin File** should already be set.

**Reference Surface:** TIN File - final.tin

**Elevation Source:** Reference TIN

**Node Elevation Option:** Same as Source

**Vertical Alignment:** Min. Fixed Drop, 0.17

**Minimum Depth:** 2.38 feet (See first note at top of next page)

**Maximum Depth:** 20.00 feet

Node Configuration - Elevations

Node ID: CB-1

Window Center: ☐ Highlight: ☐

Details

Options: ☐ Properties: ☐ Location: ☐ Spread Criteria: ☐ **Elevations**: ☐ Junction Loss: ☐ Discharge Options: ☐ Computations: ☐

Reference Surface: TIN File (final.tin)

Elevation Source: Reference TIN (880.970)

Node Elevation Option: Same as Source (880.970)

Vertical Alignment: Min. Fixed Drop (0.170)

Minimum Depth: 2.380

Maximum Depth: 20.000

Add Sump Depth: ☐ 0.000

#### NOTES:

Refer to the [TDOT GEOPAK Drainage Nodes](#) listing in Appendix A of this manual or online for **Minimum Depth**, **Maximum Depth** and **Min. Fixed Drop or Drop Across Bottom of Structure** values for a given catch basin type and pipe size.

In Node Configuration, Minimum Depth refers to the Minimum Depth of Cover. It does not refer to the minimum depth of the catch basin. Both numbers are provided as shown below in a segment of the table taken from Appendix A.

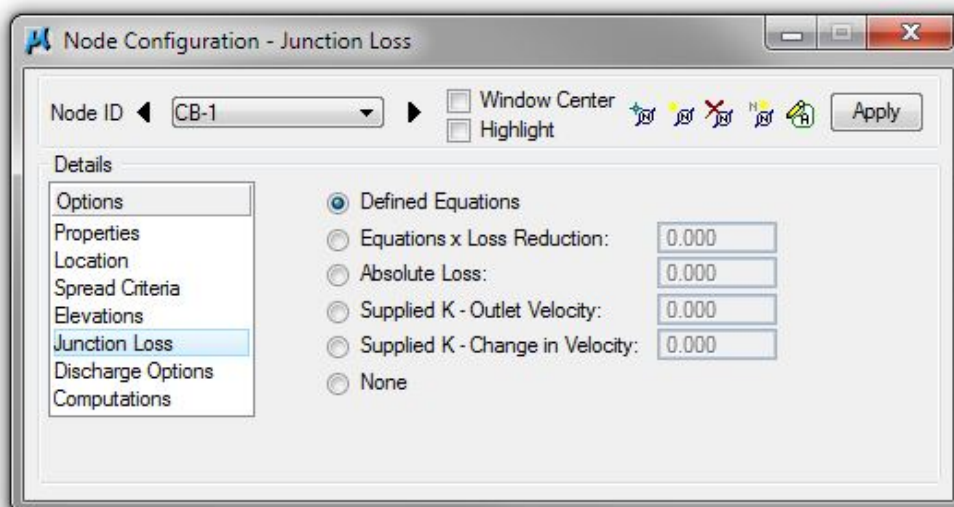
Drainage Node Name	Node Description	Cell Name	Drop Across Bottom of Structure	Max. Depth	Pipe Sizes			
					15		18	
					Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover
Type: Grate								
CB#10 32"X26"	Lowered 6-30 Curb & Grate Inlet	CB32X26S	0.12	5.00			3.74	2.12
CB#10 4X3	6" NonMount. Curb & Grate Inlet	CB4X3S	0.17	20.00			3.88	2.21
CB#10 4' DIA	6" NonMount Curb & Grate Inlet	CB4DIAS	0.17	20.00			3.88	2.21
CB#10 4X4	6" NonMount. Curb & Grate Inlet	CB4X4S	0.17	28.00			3.88	2.21
CB#12 32"X32"	6" NonMount. Curb & Grate Inlet	CB32X32	0.12	4.58			3.74	2.12
B#12 4X3	6" NonMount. Curb & Grate Inlet	CB4X3	0.17	20.00			3.88	2.21

## NOTES:

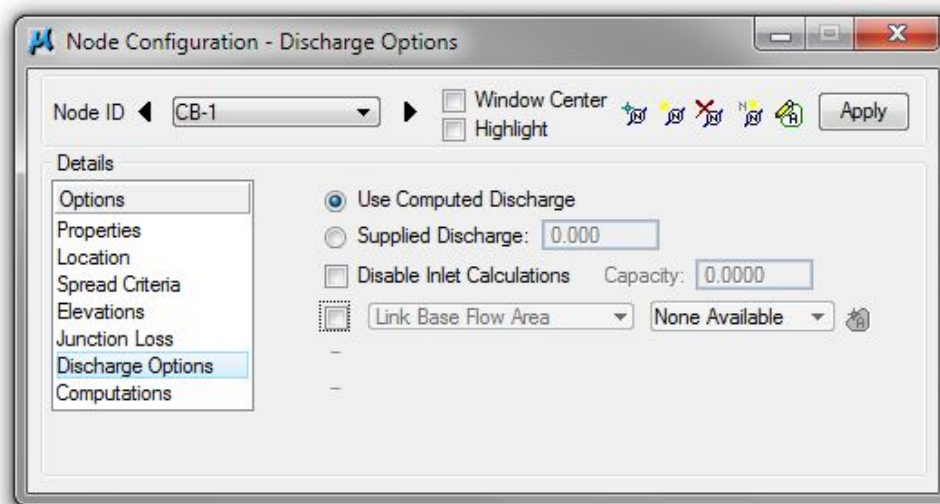
In the TDOT GEOPAK Drainage Nodes table in Appendix A “**Minimum Depth of Cover = Minimum Depth - Pipe Size - Drop Across Bottom of Structure**” for catch basins with both inlet and outlet pipes. To determine Minimum Depth of Cover for catch basins with an outlet only: add **Drop Across Bottom of Structure** to **Minimum Depth of Cover**. The first catch basin in the system is considered an outlet only because there are no other pipes (inlets) coming into it.

For the initial design, use the value given under the 18 in. pipe size. If larger pipes are designed, reset the Minimum Depth of Cover to the value for the pipe designed on and re-design the network. Steps for this procedure are given in chapter 9 on **Drainage Navigator /Querying**.

**Step 9. Junction Losses > Set to Use Defined Equations** (This defaults to the project preference settings that were set in Exercise 1):

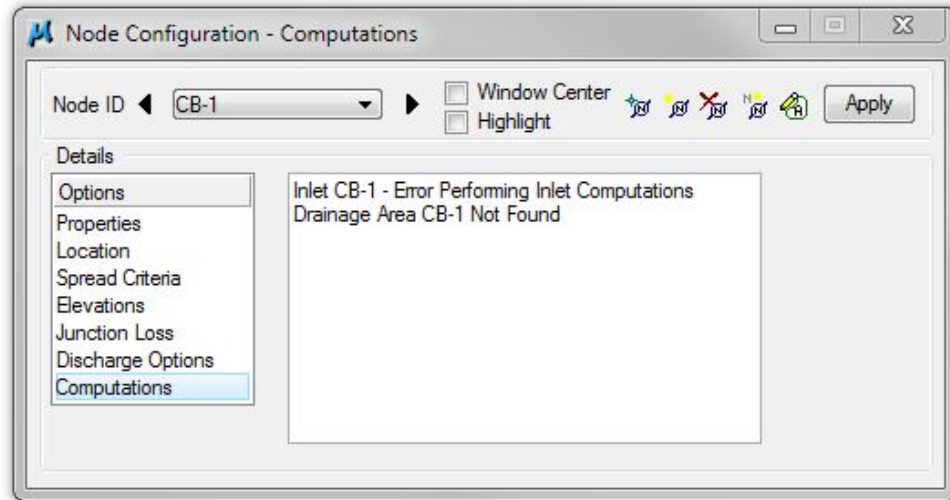


**Step 10. Discharge Options > Specify the source of the discharge contributing to this inlet. Toggle Use Computed Discharge:**



**Step 11. Computations >** Verify the inlet's hydraulic computations:

**NOTE:** The Drainage Area for this node hasn't been added; therefore, the computations for the node can't be completed until a discharge is known.

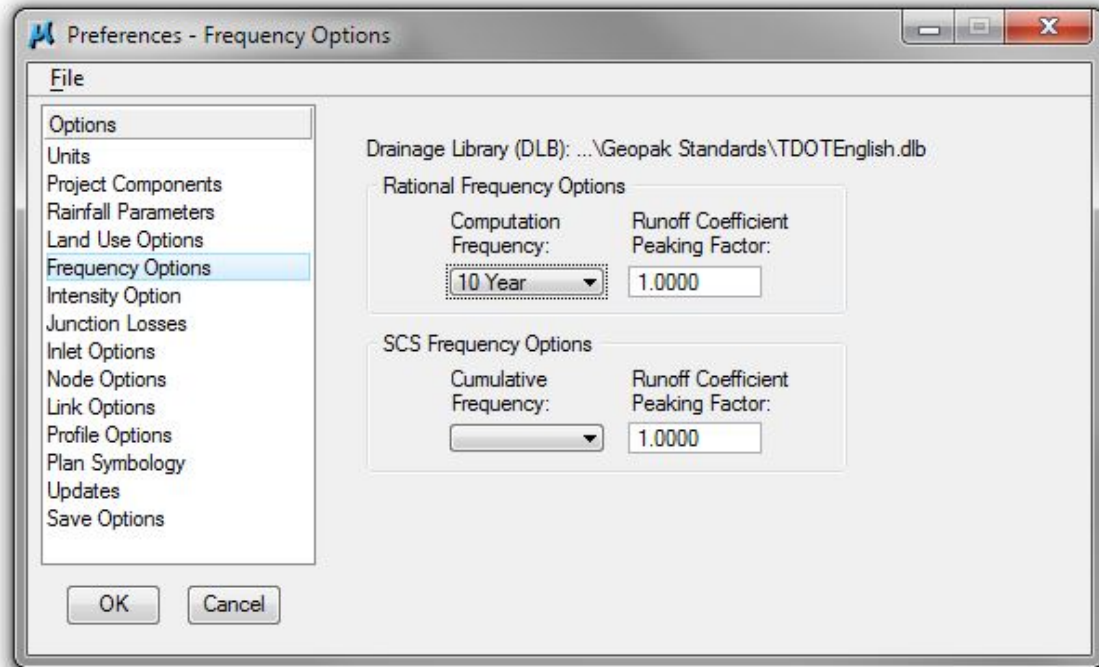


**Step 12.** Add this Node to the project by pressing the **Apply** button.

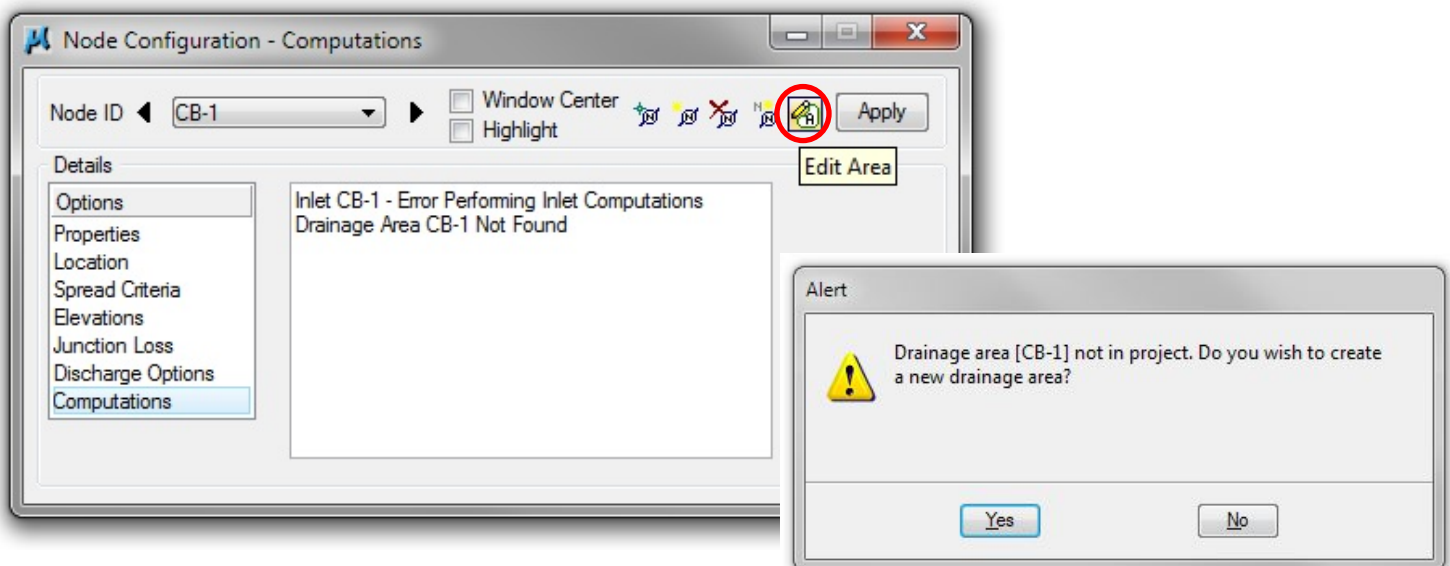


## 5.2 Design Drainage Area CB – 1

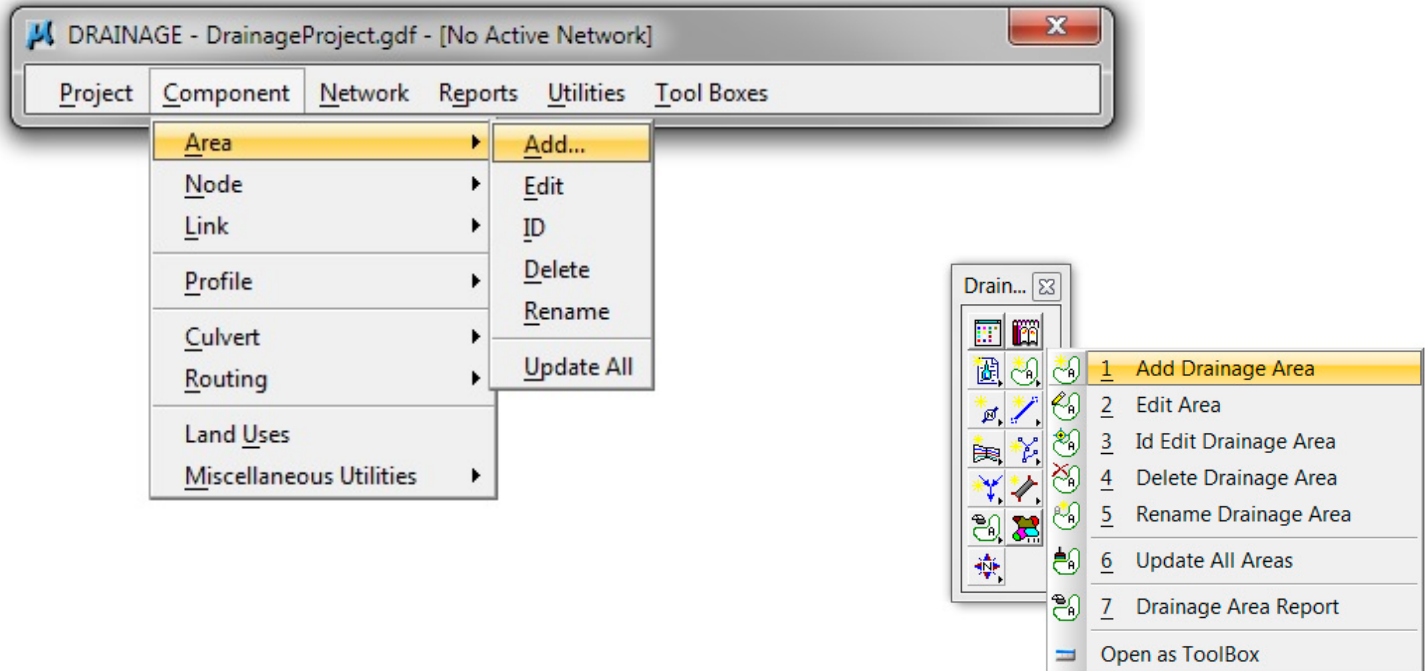
- Step 1.** According to the [TDOT Drainage Manual Chapter 4](#) Table 4-1 *Hydrologic Design Criteria* the drainage area for CB-1 should be calculated for a 10 year frequency. Select **Project>Preferences** and change the Frequency Options to the 10 Year Storm. Click the **OK** button to accept the new preference settings.



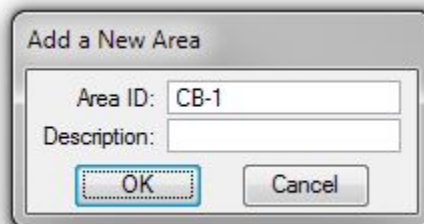
- Step 2.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**.



**NOTE:** If you have closed the Node Configuration Dialog you may create a new Drainage Area by going to the Drainage Main Menu Bar, and selecting **Component > Area > Add** OR from the Main Toolbar and selecting **Add Drainage Area**.



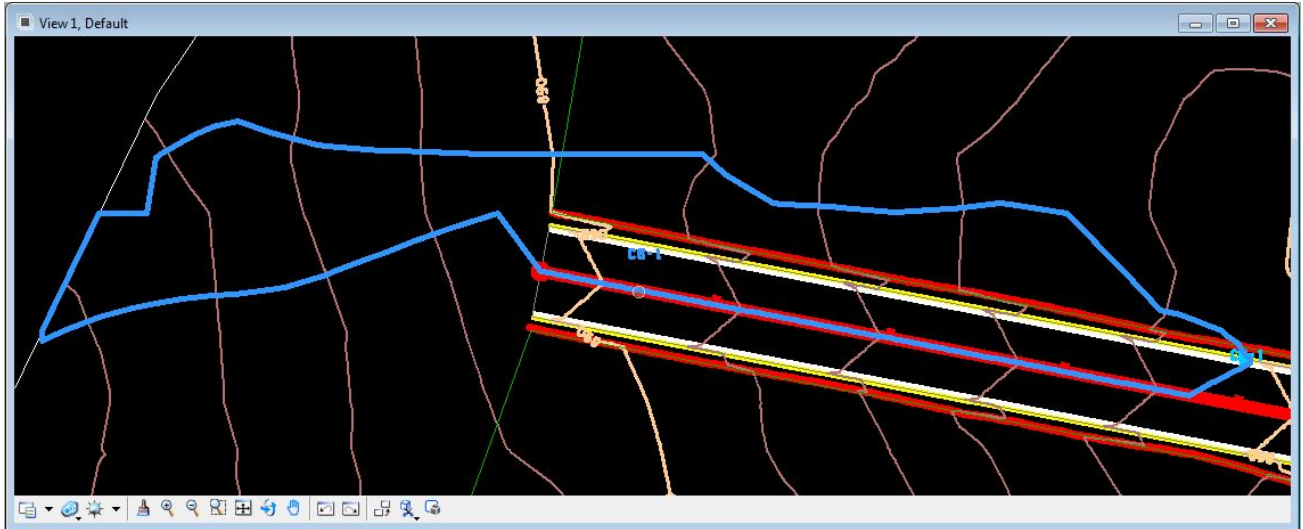
The following Add a New Area dialog box will pop up. Click **OK**.



## Exercise 5

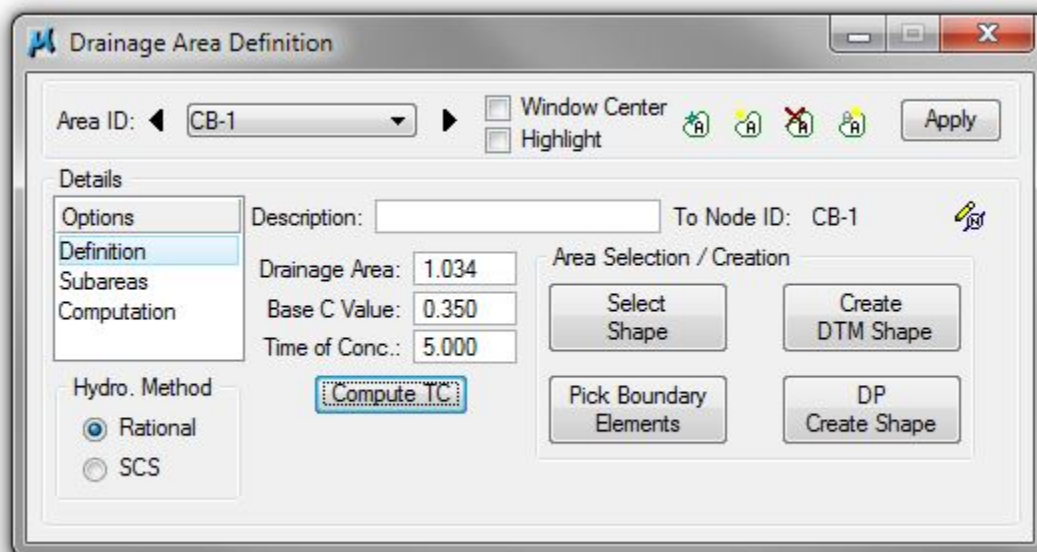
**Step 3.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 1. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

Delineate Drainage Area:



Define Drainage Area:

Use Select Shape to identify the drainage area. Our Base C Value was set previously in the culvert exercise.



This Base C Value should be set to the most common land use item within your project area then only the remaining areas would need land use shapes developed for them.

Calculate Time of Concentration:

**Time of Concentration**

Drainage Area ID: CB-1

TIN File: final.tin

Define Path: Trace ID - Segments

☒ **Sheet Flow**  
 Method: FHA Length: 26.000  
 n Value: 0.040 Slope: 2.446

☒ **Shallow Flow**  
 Length: 300.000  
 Inter. K: 0.619 Slope: 2.942

☒ **Concentrated Flow**  
 Method: Continuity Length: 385.774  
 Velocity: 5.000

Accum. Distance: 711.774  
 Accum. Avg. Slope: 2.537

**Tc= 4.058** Compute Apply

**Details**

Distance	Slope	Avg. Slope	Flow
20.12	2.29	2.29	Sheet
5.88	2.98	2.45	Sheet
9.32	2.98	2.59	Shallow
17.75	2.55	2.57	Shallow
10.01	2.80	2.61	Shallow
22.32	2.56	2.60	Shallow
7.10	2.78	2.61	Shallow
25.20	2.90	2.67	Shallow
3.59	2.81	2.68	Shallow
12.84	3.65	2.77	Shallow
12.34	3.85	2.86	Shallow
5.34	3.14	2.87	Shallow
19.79	3.07	2.89	Shallow
14.55	3.10	2.91	Shallow

Distance: 20.120 Slope: 2.290 Adjust Flow

Max Sheet Flow Distance: 26.000  
 Max Shallow Flow Distance: 300.000

Apply

If the calculated Time of Concentration is less than the minimum of 5 minutes, then **5 must be manually typed** in the Drainage Area Definition dialog after hitting apply in the Time of Concentration Window.

Delineate Subareas utilizing the Land Use DGN:

**Drainage Area Subareas**

Area ID: CB-1

☐ Window Center ☐ Highlight

**Details**

Options Definition Subareas Computation

Hydro. Method: ☒ Rational ☐ SCS

To Node ID: CB-1

Subarea	C Value	Description
0.2316	0.900	Conc/Asphalt Pvmnt
0.3253	0.300	Forested Areas

Automatic Delineation

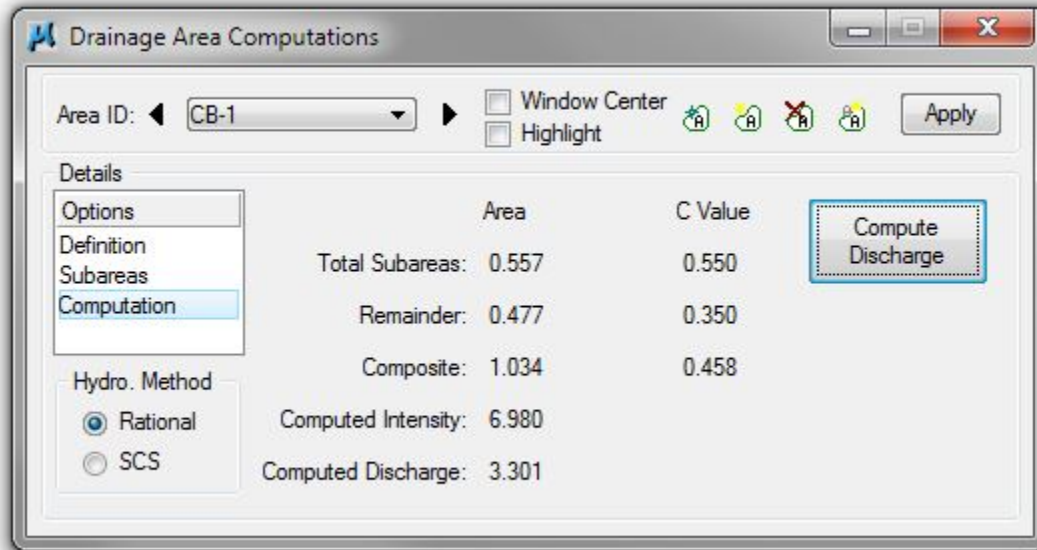
☒ Display Only

0.325 0.300 Forested Areas



## Exercise 5

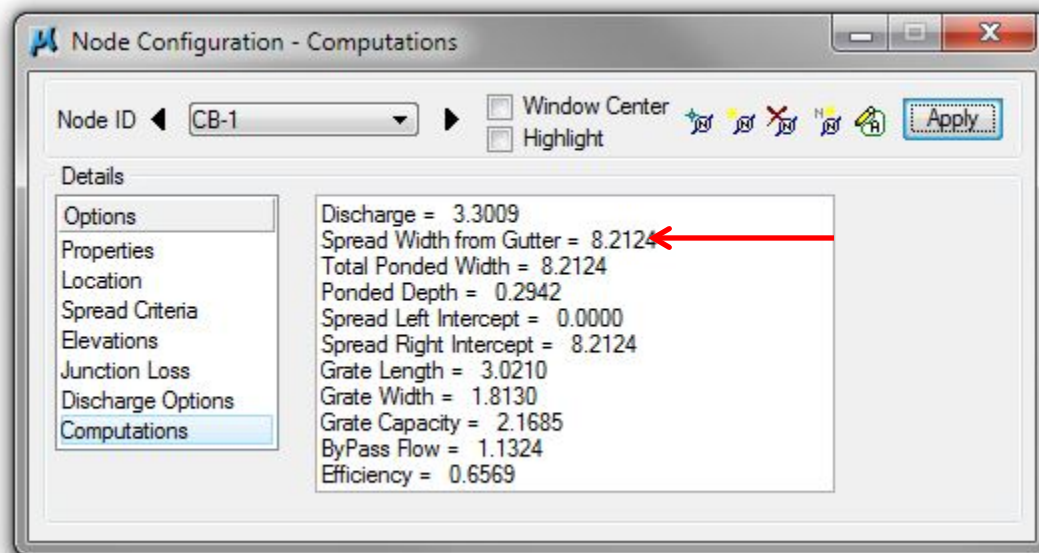
Compute Discharge and Apply:



The 'Drainage Area Computations' dialog box shows the 'Area ID' as 'CB-1'. The 'Details' section on the left has 'Options', 'Definition', 'Subareas', and 'Computation' (selected). The 'Hydro. Method' section has 'Rational' selected. The 'Compute Discharge' button is highlighted with a red box.

	Area	C Value
Total Subareas:	0.557	0.550
Remainder:	0.477	0.350
Composite:	1.034	0.458
Computed Intensity:	6.980	
Computed Discharge:	3.301	

**Step 4.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



The 'Node Configuration - Computations' dialog box shows the 'Node ID' as 'CB-1'. The 'Details' section on the left has 'Options', 'Properties', 'Location', 'Spread Criteria', 'Elevations', 'Junction Loss', 'Discharge Options', and 'Computations' (selected). The 'Compute Discharge' button is highlighted with a red box.

Discharge =	3.3009
Spread Width from Gutter =	8.2124
Total Ponded Width =	8.2124
Ponded Depth =	0.2942
Spread Left Intercept =	0.0000
Spread Right Intercept =	8.2124
Grate Length =	3.0210
Grate Width =	1.8130
Grate Capacity =	2.1685
ByPass Flow =	1.1324
Efficiency =	0.6569

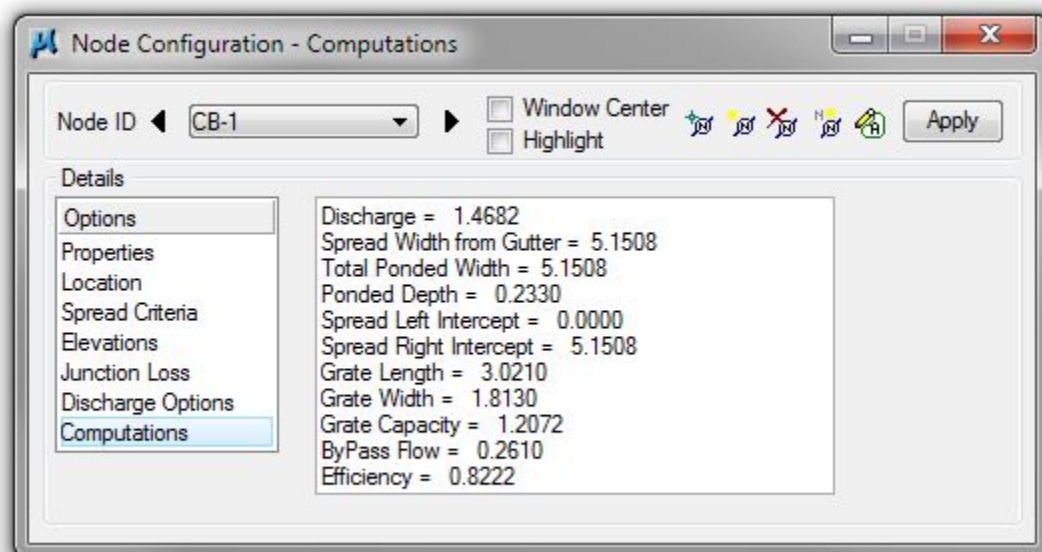
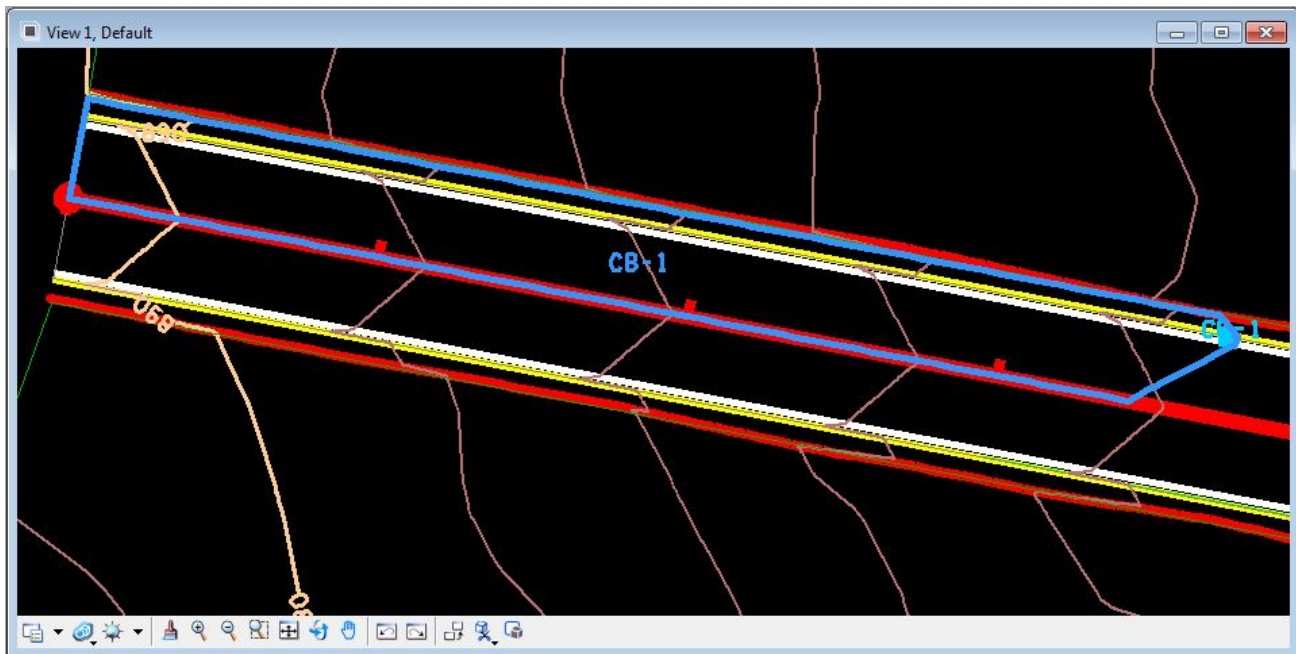
Don't be alarmed if your results are off by a few 100<sup>th</sup>s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** exceeds our maximum spread of 8.0 feet which was determined in Step 1 of Exercise 5.1



In the Node Configuration – Location dialog change the station to 3+70.00, click Apply and repeat Exercise 5.2.

You should come out with something similar to this:

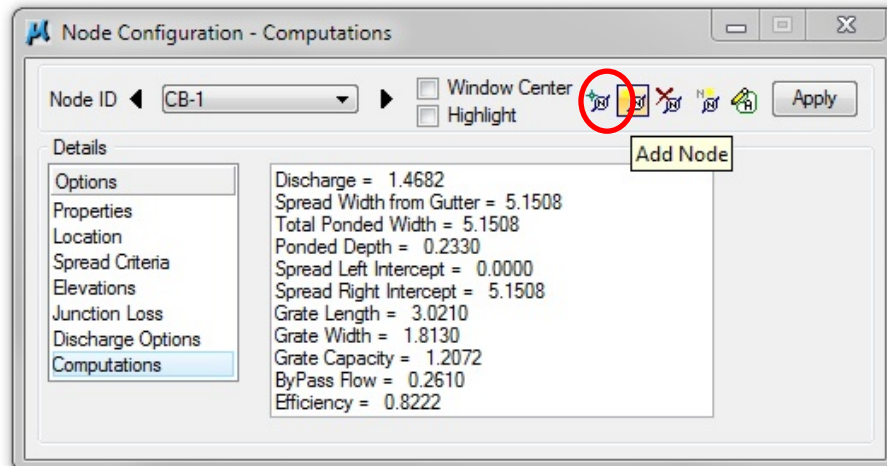


**NOTE:** The Spread Width is now within our limits.

## 5.3 Design Inlet CB – 2

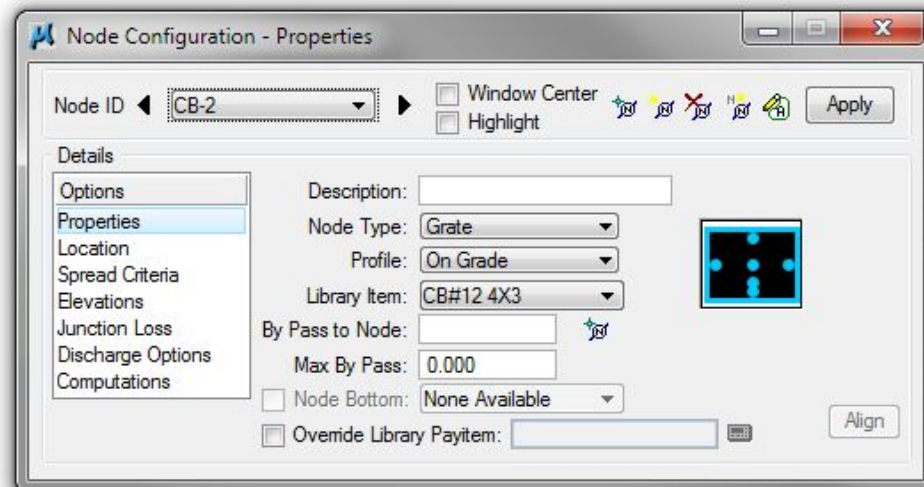
CB- 2 will be at the same station as CB-1 but will be on the right side of the road. Many of the parameters will be defaulted to those used to place CB-1.

- Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog.



- Step 2.** Click **OK** to add CB-2. CB-2 will automatically take the place of CB-1 in the Node Configuration dialog which is already open.

- Step 3.** **Properties >** Verify the Node Properties are defaulted from the previous Node (CB-1) such that no user-input is required for this similar curb inlet.

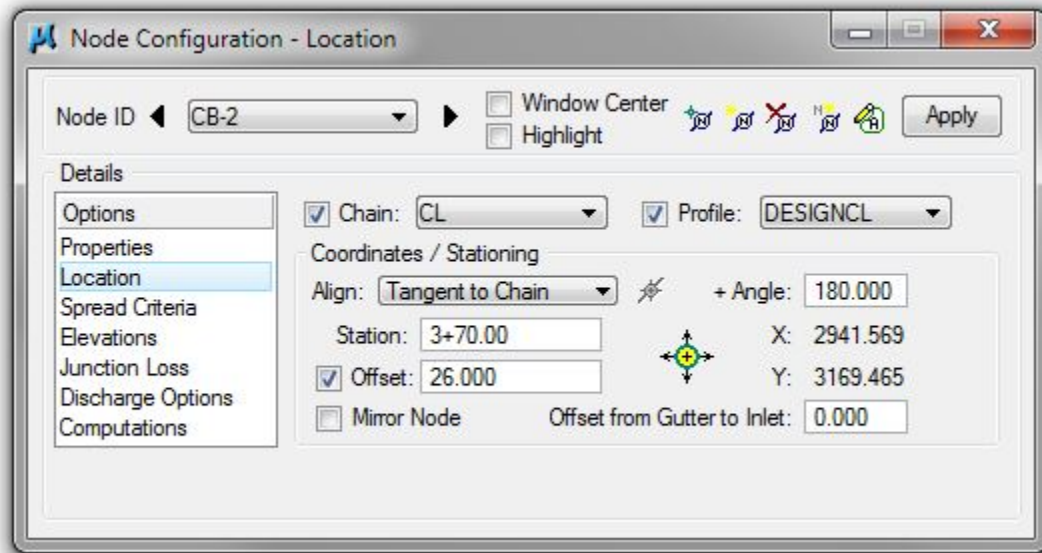


**Step 4. Location** > All Reference information is defaulted from the previous Node (CB-1) such that only the **+ Angle (OR Mirror Node but NOT both)** and the **Offset** needs to be changed. Change the

**Angle:** \*180 (or toggle on Mirror Node)

**Offset:** 26.00

\*(180 for Right side, 0 for the Left), (Mirror Node ON for the Right, OFF for the Left)

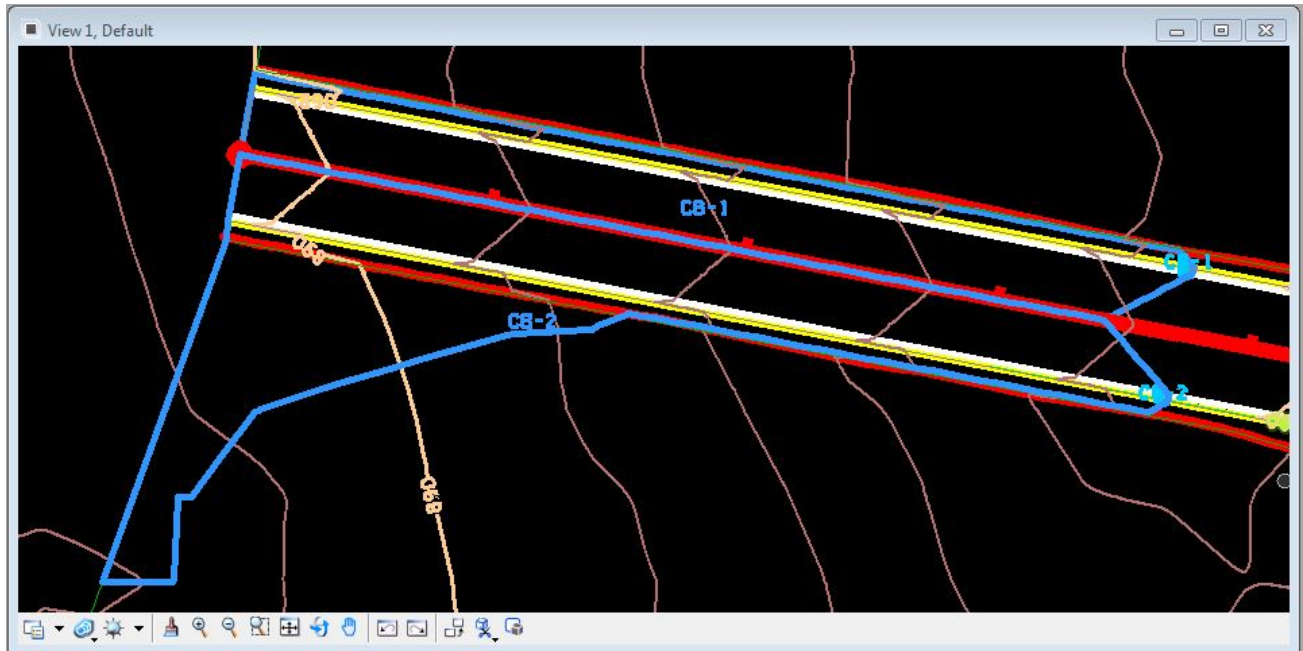


**Step 5.** Click **Apply** to include this node in the Drainage Project.

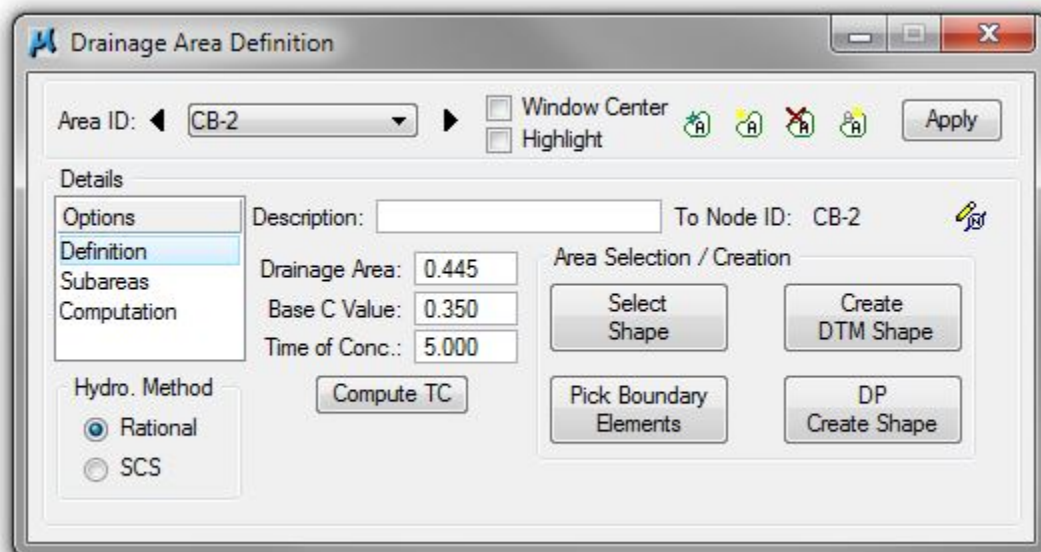
## 5.4 Design Drainage Area CB – 2

- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-2** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 2. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

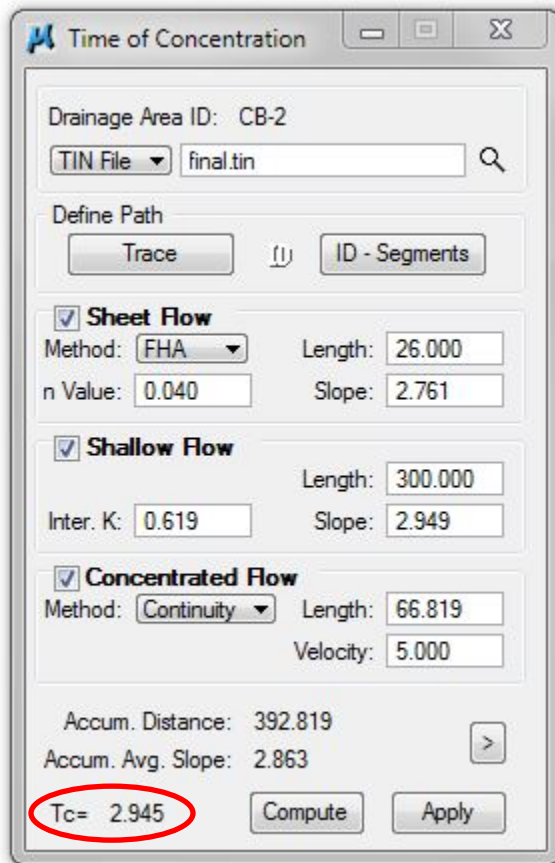
Delineate Drainage Area:



Define Drainage Area:



Calculate Time of Concentration:



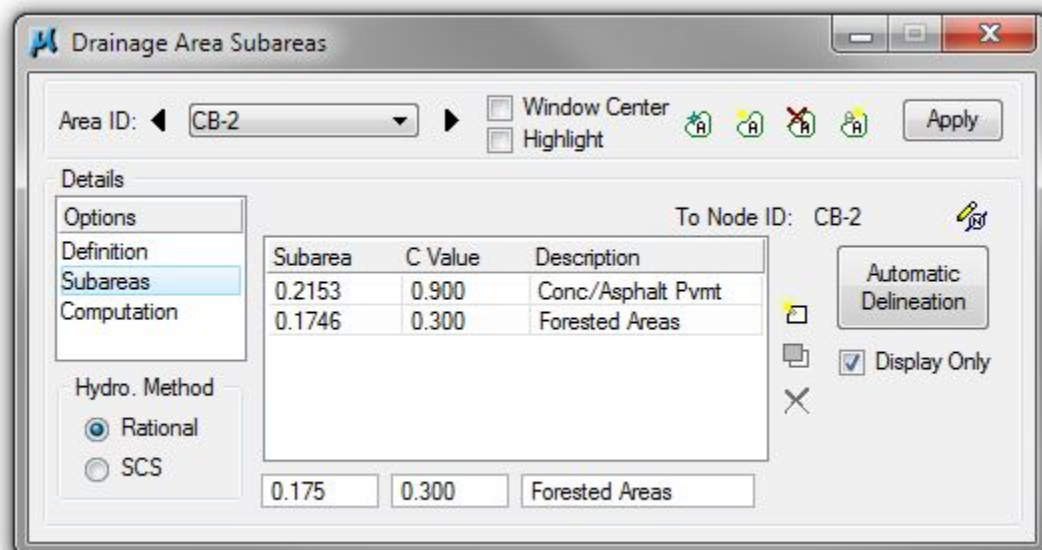
The 'Time of Concentration' dialog box is shown. It includes fields for 'Drainage Area ID' (CB-2), 'TIN File' (final.tin), and 'Define Path' (Trace, ID - Segments). It has three sections: 'Sheet Flow' (Method: FHA, Length: 26.000, n Value: 0.040, Slope: 2.761), 'Shallow Flow' (Length: 300.000, Inter. K: 0.619, Slope: 2.949), and 'Concentrated Flow' (Method: Continuity, Length: 66.819, Velocity: 5.000). At the bottom, it shows 'Accum. Distance: 392.819' and 'Accum. Avg. Slope: 2.863'. The 'Tc=' field is circled in red and contains the value 2.945. There are 'Compute' and 'Apply' buttons.

Flow Type	Method	Length	n Value	Slope	Velocity
Sheet Flow	FHA	26.000	0.040	2.761	
Shallow Flow		300.000		2.949	
Concentrated Flow	Continuity	66.819			5.000

Accum. Distance: 392.819  
Accum. Avg. Slope: 2.863  
Tc= 2.945

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore **5 must be manually typed** in the Drainage Area Definition dialog after hitting apply in the Time of Concentration Window.

Delineate Subareas utilizing the Land Use DGN:



The 'Drainage Area Subareas' dialog box is shown. It includes 'Area ID' (CB-2), 'Window Center', 'Highlight', and 'Apply' buttons. It has a 'Details' section with 'Options', 'Definition', 'Subareas', and 'Computation' tabs. The 'Subareas' tab is selected, showing a table with columns 'Subarea', 'C Value', and 'Description'. The 'Hydro. Method' section has 'Rational' and 'SCS' options. There are 'Automatic Delineation' and 'Display Only' buttons.

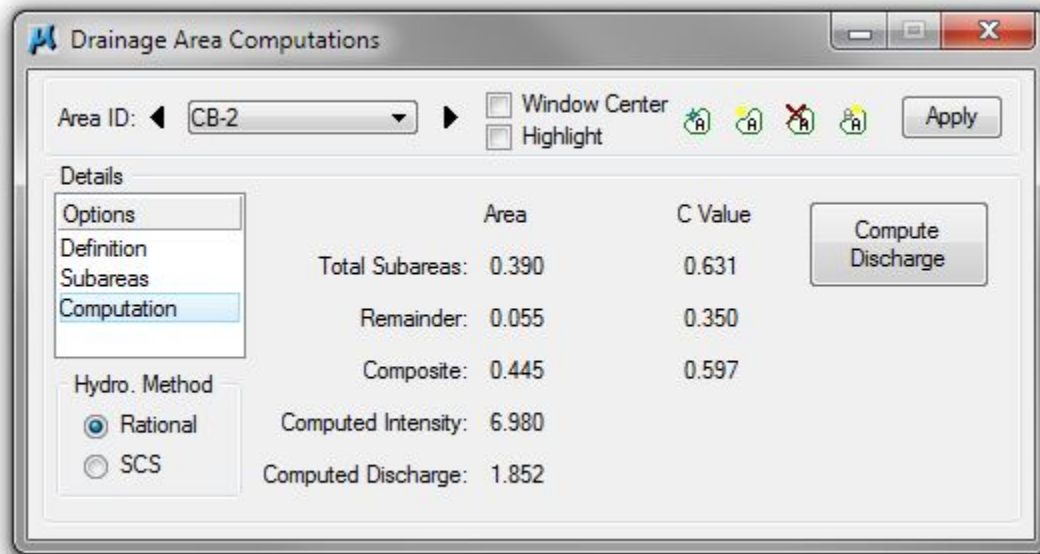
Subarea	C Value	Description
0.2153	0.900	Conc./Asphalt Pvmnt
0.1746	0.300	Forested Areas

Hydro. Method: Rational (selected), SCS  
Automatic Delineation, Display Only

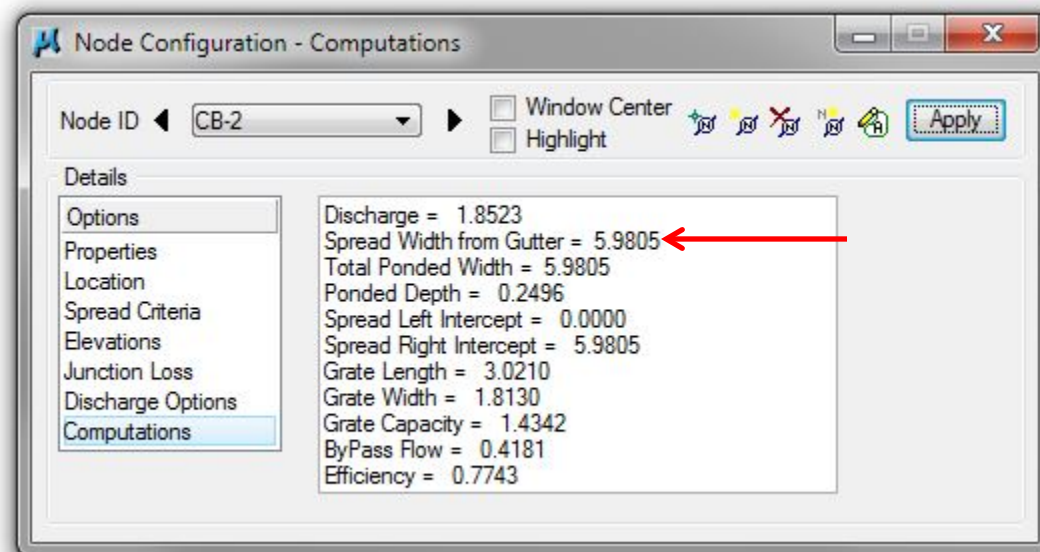


## Exercise 5

Compute Discharge and Apply:



**Step 3.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



Don't be alarmed if your results are off by a few 100<sup>th</sup>s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

## 5.5 Design Inlet CB – 3

- Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog.

Click **OK** to set the name CB-3

**Properties >** Verify the Node Properties are defaulted from the previous Node such that no user-input is required:

The dialog box is titled "Node Configuration - Properties". It features a "Node ID" dropdown set to "CB-3". On the right, there are checkboxes for "Window Center" and "Highlight", along with several small icons and an "Apply" button. A "Details" sidebar on the left lists "Options", "Properties" (which is selected), "Location", "Spread Criteria", "Elevations", "Junction Loss", "Discharge Options", and "Computations". The main area contains the following fields: "Description:" (empty), "Node Type:" (Grate), "Profile:" (On Grade), "Library Item:" (CB#12 4X3), "By Pass to Node:" (empty), "Max By Pass:" (0.000), "Node Bottom:" (None Available), and "Override Library Payitem:" (empty). A small square icon representing a grate is shown on the right. An "Align" button is located at the bottom right.

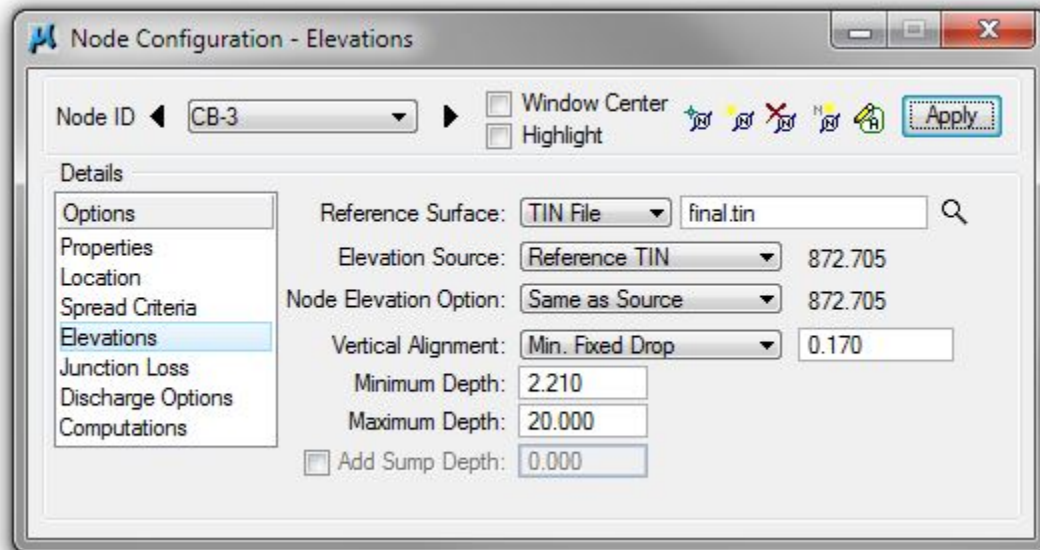
- Step 2.** **Location >** All Reference information is defaulted from the previous Node (CB-2) such that only the **+ Angle**, **Station** and the **Offset** needs to be changed. After a few iterations it was determined that CB-3 should be placed at Station 6+20.00:

The dialog box is titled "Node Configuration - Location". It has the same "Node ID" dropdown set to "CB-3" and the same "Window Center" and "Highlight" checkboxes as the previous dialog. The "Details" sidebar on the left lists "Options", "Properties", "Location" (which is selected), "Spread Criteria", "Elevations", "Junction Loss", "Discharge Options", and "Computations". The main area contains the following fields: "Chain:" (CL), "Profile:" (DESIGNCL), "Coordinates / Stationing" section with "Align:" (Tangent to Chain), "Station:" (6+20.00), "+ Angle:" (0.000), "Offset:" (-26.000), "Mirror Node" (unchecked), and "Offset from Gutter to Inlet:" (0.000). A small icon representing a node location is shown in the center. The "X" and "Y" coordinates are displayed as 3196.887 and 3173.550 respectively. An "Apply" button is located at the top right.

## Exercise 5

**Step 3.** **Elevation** > Reset Minimum Depth for a node with both inlet and outlet pipes.

**Minimum Depth:** 2.21 FT



The image shows a software dialog box titled "Node Configuration - Elevations". At the top, there is a "Node ID" dropdown menu set to "CB-3". To its right are checkboxes for "Window Center" and "Highlight", along with several small icons and an "Apply" button. Below this is a "Details" section with a list of tabs on the left: "Options", "Properties", "Location", "Spread Criteria", "Elevations" (which is highlighted), "Junction Loss", "Discharge Options", and "Computations". The main area of the dialog contains the following settings:

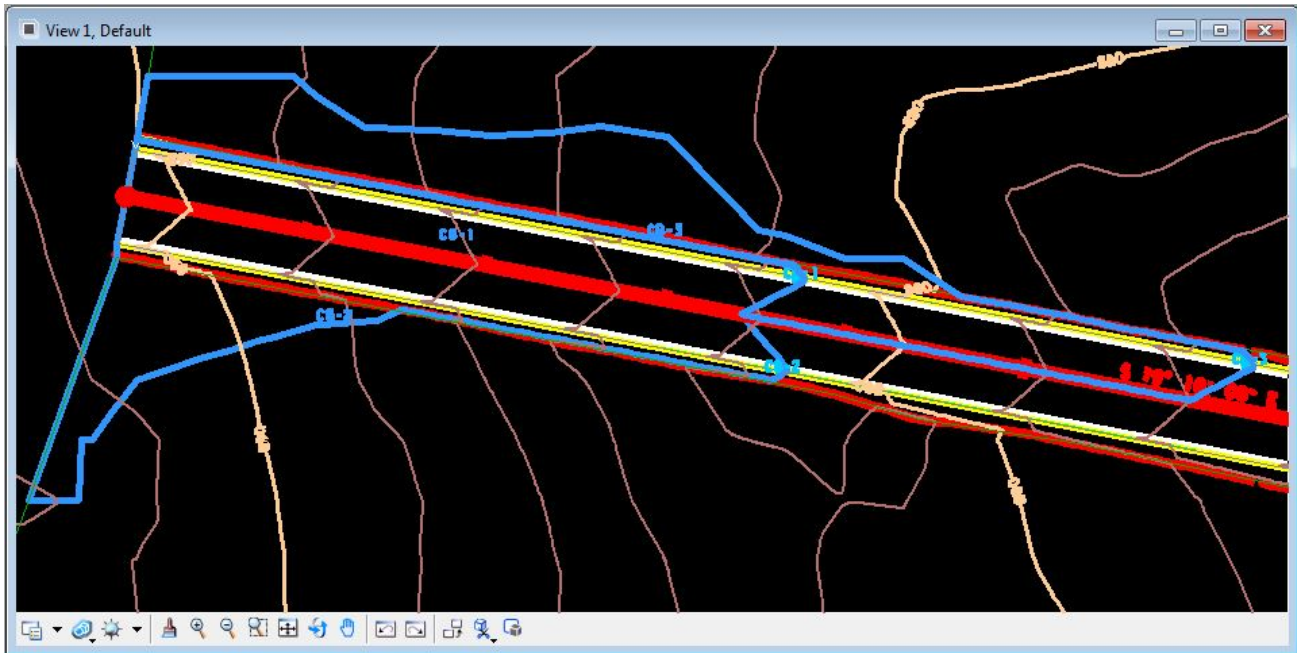
- Reference Surface: TIN File (dropdown) with a text field containing "final.tin" and a search icon.
- Elevation Source: Reference TIN (dropdown) with a value of 872.705.
- Node Elevation Option: Same as Source (dropdown) with a value of 872.705.
- Vertical Alignment: Min. Fixed Drop (dropdown) with a value of 0.170.
- Minimum Depth: 2.210 (text field).
- Maximum Depth: 20.000 (text field).
- ☐ Add Sump Depth: 0.000 (text field).

**Step 4.** Click the **Apply** button to include this node in the Drainage Project.

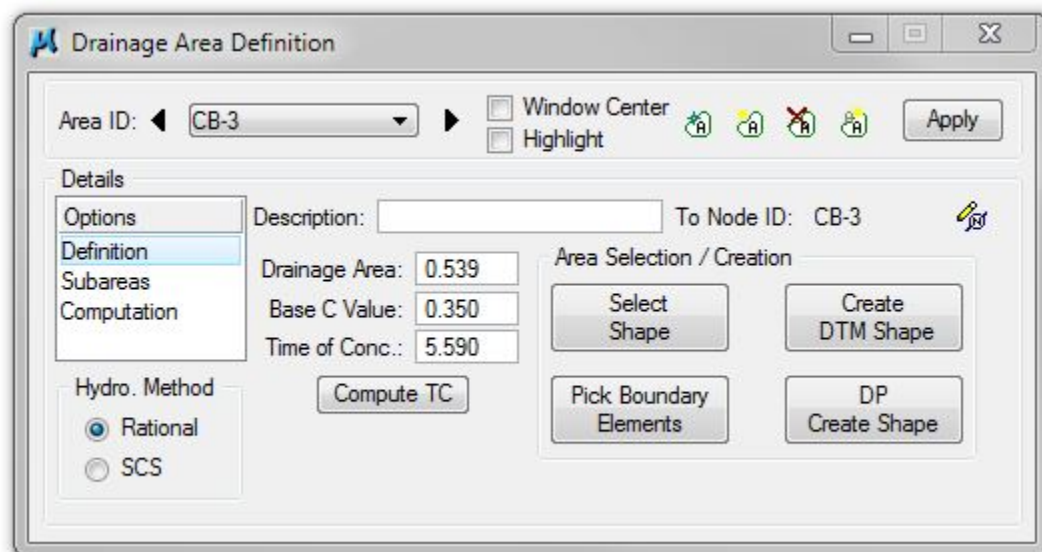
## 5.6 Create Drainage Area CB – 3

- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-3** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 3. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

Delineate Drainage Area:

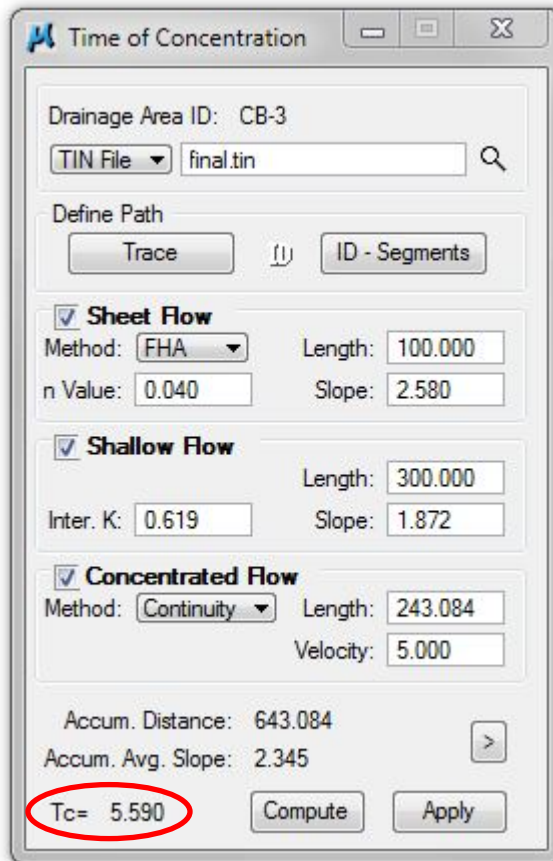


Define Drainage Area:



## Exercise 5

Calculate Time of Concentration:



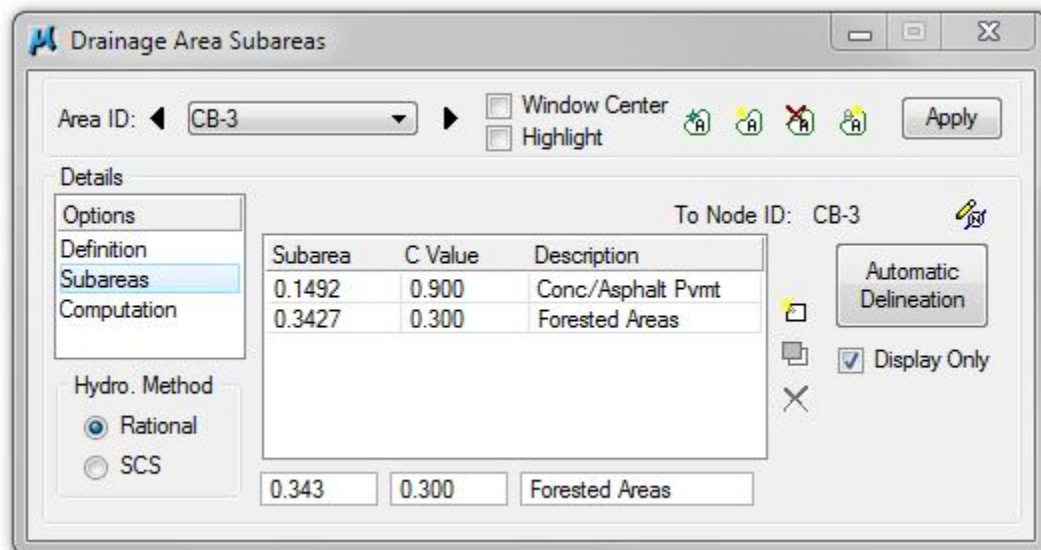
The dialog box is titled "Time of Concentration". It contains the following fields and controls:

- Drainage Area ID: CB-3
- TIN File: final.tin
- Define Path: Trace, ID - Segments
- ☒ Sheet Flow
  - Method: FHA
  - Length: 100.000
  - n Value: 0.040
  - Slope: 2.580
- ☒ Shallow Flow
  - Length: 300.000
  - Inter. K: 0.619
  - Slope: 1.872
- ☒ Concentrated Flow
  - Method: Continuity
  - Length: 243.084
  - Velocity: 5.000
- Accum. Distance: 643.084
- Accum. Avg. Slope: 2.345
- Tc= 5.590 (circled in red)
- Buttons: Compute, Apply

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required.

**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area.

Delineate Subareas utilizing the Land Use DGN:



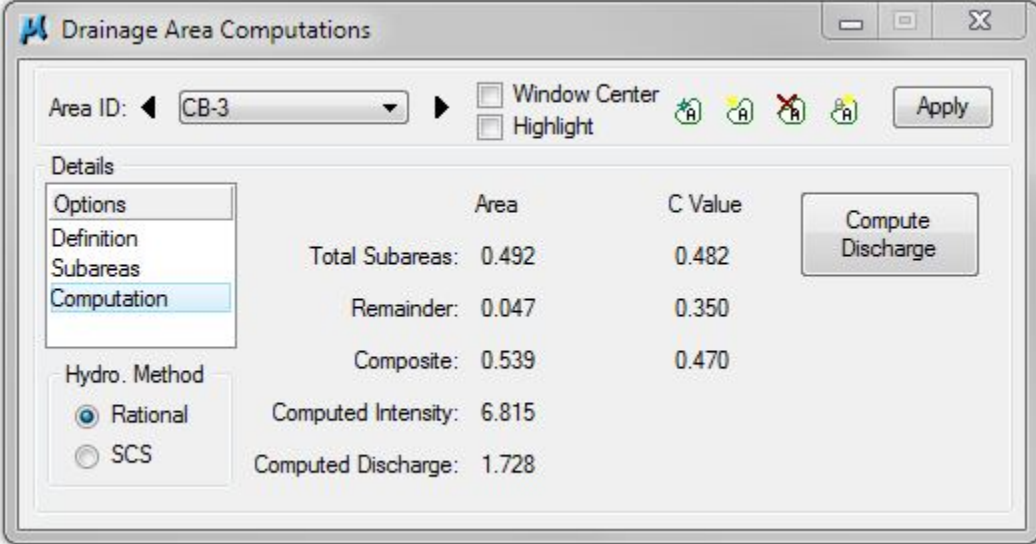
The dialog box is titled "Drainage Area Subareas". It contains the following fields and controls:

- Area ID: CB-3
- Window Center: ☐
- Highlight: ☐
- Apply button
- Details
  - Options
  - Definition
  - Subareas (selected)
  - Computation
- Hydro. Method
  - ☒ Rational
  - ☐ SCS
- To Node ID: CB-3
- Automatic Delineation button
- Display Only: ☒
- Table:

Subarea	C Value	Description
0.1492	0.900	Conc./Asphalt Pvmnt
0.3427	0.300	Forested Areas
- Summary row: 0.343, 0.300, Forested Areas



Compute Discharge and Apply:

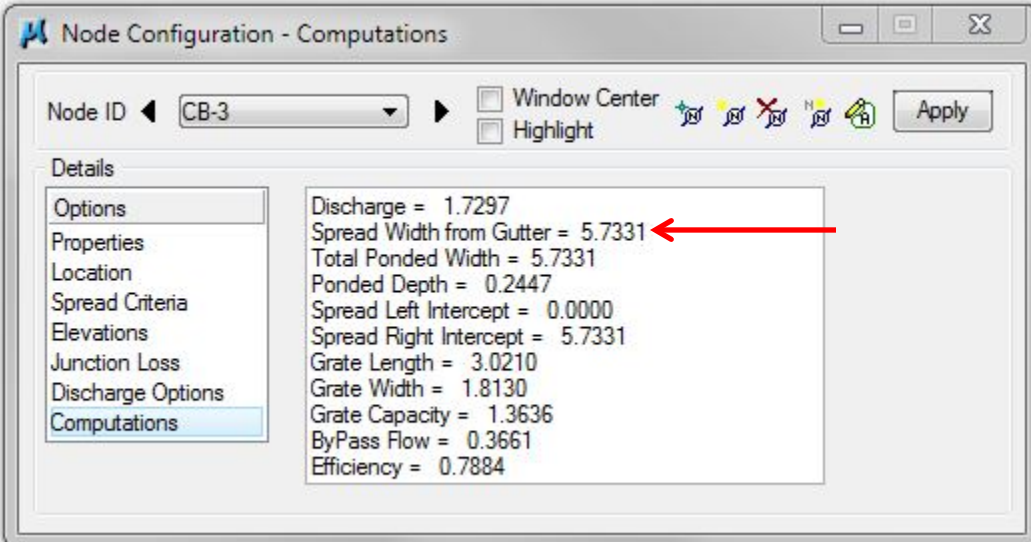


The 'Drainage Area Computations' dialog box shows the 'Area ID' as 'CB-3'. The 'Details' section on the left has 'Options', 'Definition', 'Subareas', and 'Computation' (selected). The 'Hydro. Method' section has 'Rational' selected and 'SCS' unselected. The main area displays a table of computations:

	Area	C Value
Total Subareas:	0.492	0.482
Remainder:	0.047	0.350
Composite:	0.539	0.470
Computed Intensity:	6.815	
Computed Discharge:	1.728	

Buttons for 'Window Center', 'Highlight', 'Apply', and 'Compute Discharge' are present.

**Step 3.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



The 'Node Configuration - Computations' dialog box shows the 'Node ID' as 'CB-3'. The 'Details' section on the left has 'Options', 'Properties', 'Location', 'Spread Criteria', 'Elevations', 'Junction Loss', 'Discharge Options', and 'Computations' (selected). The main area displays a list of computed values:

- Discharge = 1.7297
- Spread Width from Gutter = 5.7331
- Total Ponded Width = 5.7331
- Ponded Depth = 0.2447
- Spread Left Intercept = 0.0000
- Spread Right Intercept = 5.7331
- Grate Length = 3.0210
- Grate Width = 1.8130
- Grate Capacity = 1.3636
- ByPass Flow = 0.3661
- Efficiency = 0.7884

A red arrow points to the 'Spread Width from Gutter' value. Buttons for 'Window Center', 'Highlight', 'Apply', and 'Compute Discharge' are present.

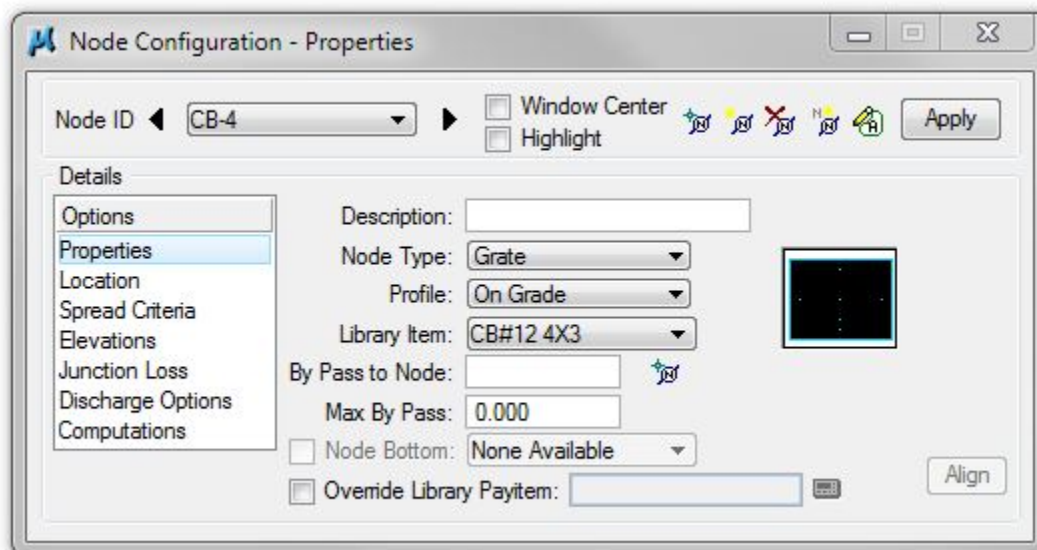
Don't be alarmed if your results are off by a few 100<sup>th</sup>s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

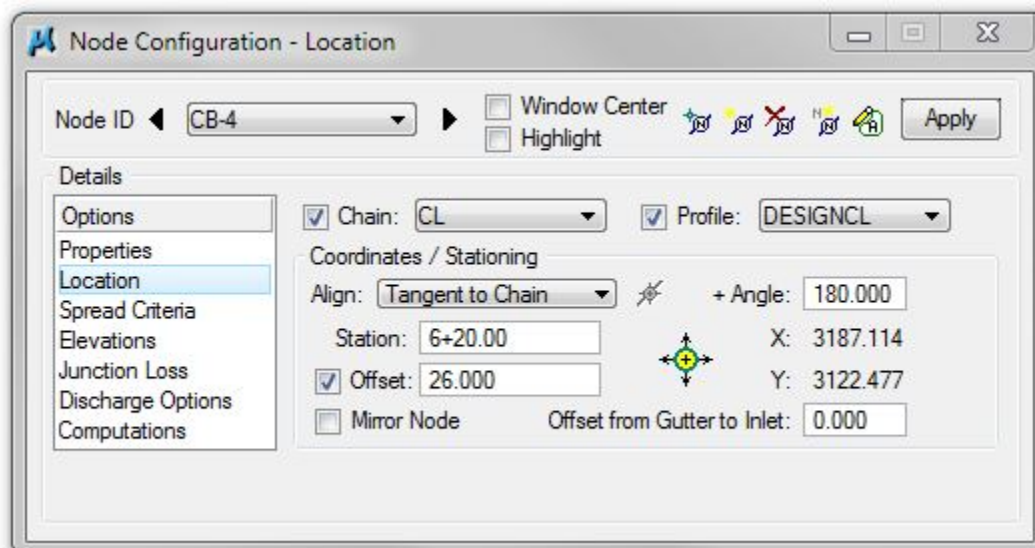
## 5.7 Design Inlet CB – 4

- Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog. Click **OK** to set the name CB-4.

**Properties >** Verify the Node Properties are defaulted from the previous Node such that no user-input is required:



- Step 2.** **Location >** All Reference information is defaulted from the previous Node (CB-3) such that only the **+ Angle**, **Station** and the **Offset** needs to be changed. We will set this catch basin at the same Station as CB-3.:

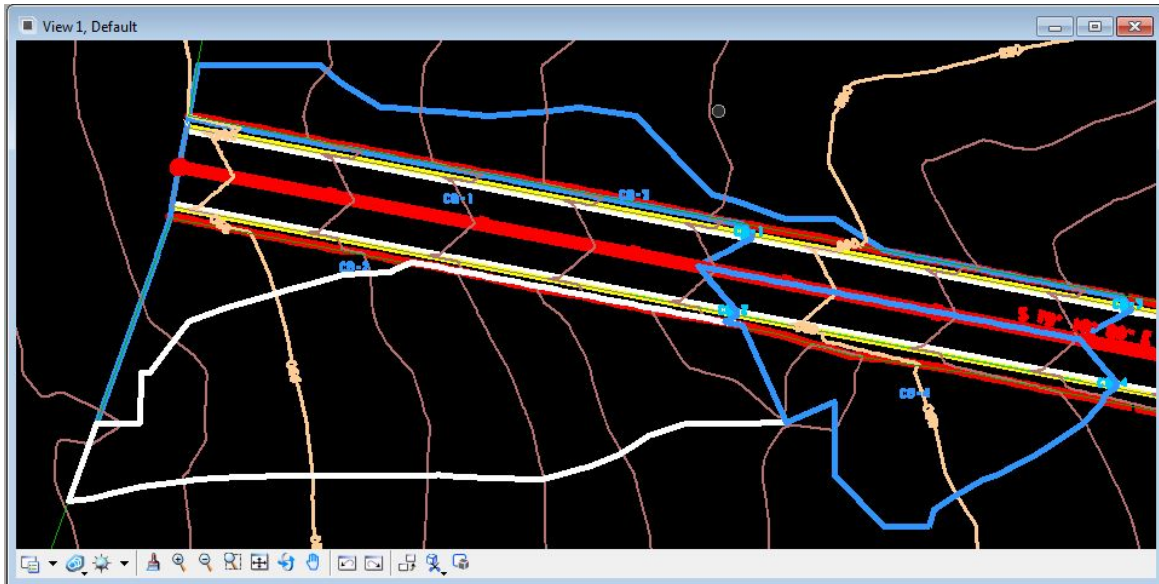


- Step 3.** Click the **Apply** button to include this node in the Drainage Project.

## 5.8 Create Drainage Area CB – 4

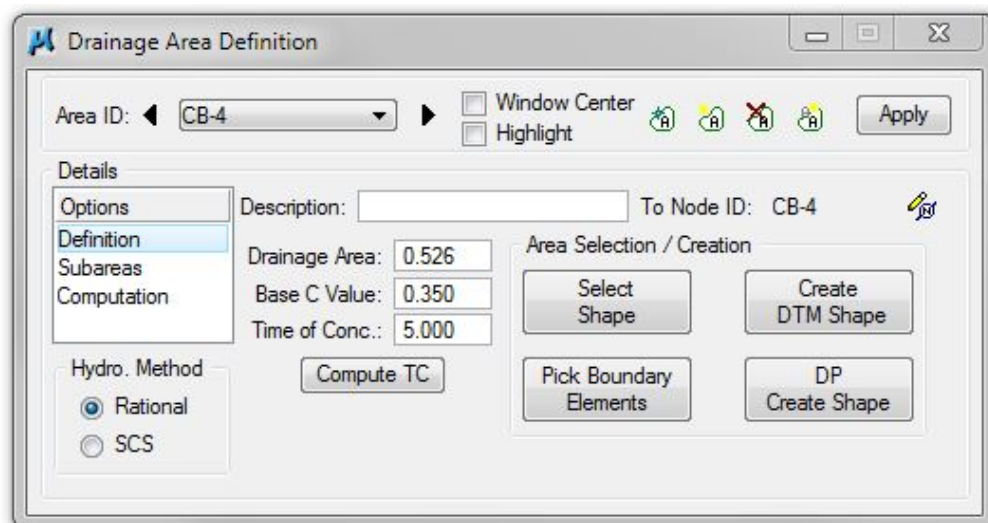
- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-4** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 4. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

Delineate Drainage Area:



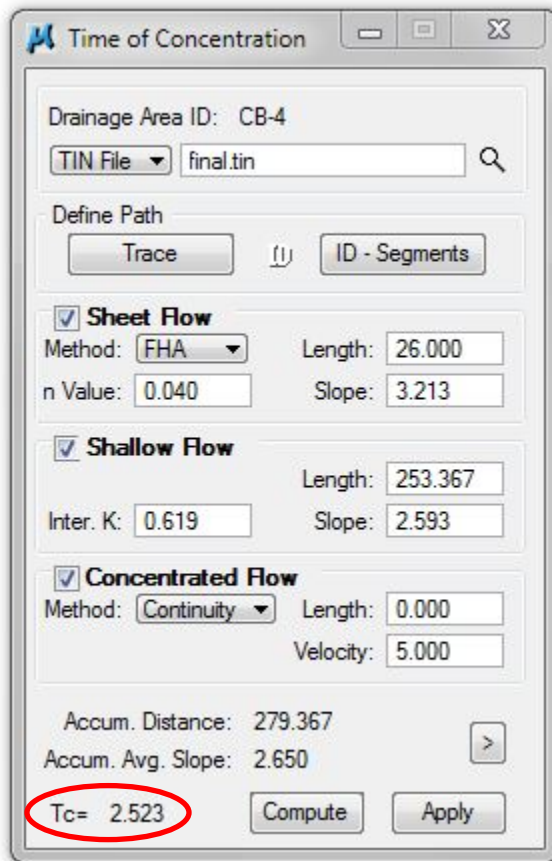
**NOTE:** After a first iteration the spread for the entire contributing drainage area was found to exceed the spread limit. After consideration it was determined an area drain could collect the water before it spills over the back of the curb. The white shape shows the drainage area to be captured by that area drain. (See next Exercise 5.9)

Define Drainage Area:



## Exercise 5

Calculate Time of Concentration:



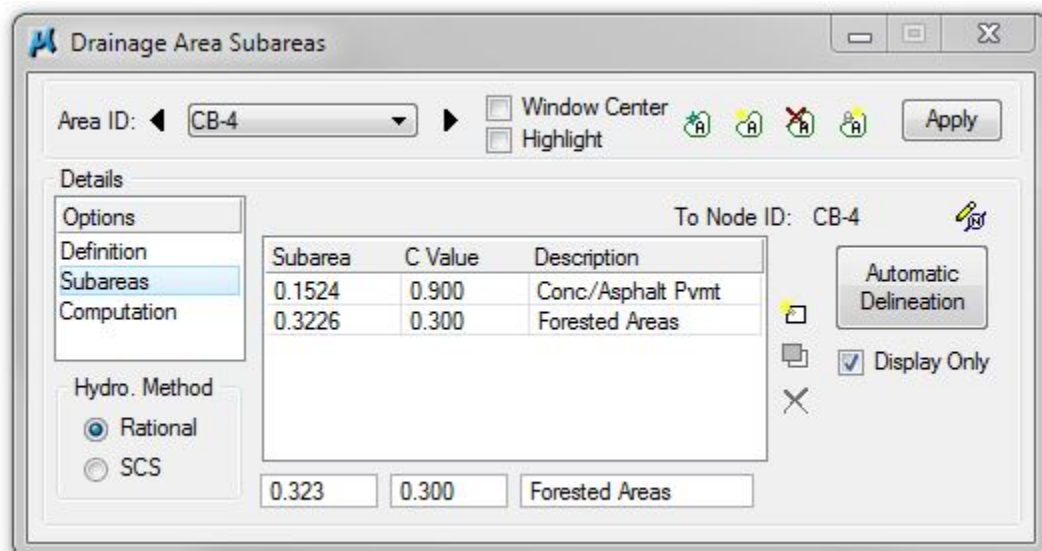
The Time of Concentration dialog box is shown with the following settings:

- Drainage Area ID: CB-4
- TIN File: final.tin
- Define Path: ID - Segments
- ☒ **Sheet Flow**
  - Method: FHA
  - Length: 26.000
  - n Value: 0.040
  - Slope: 3.213
- ☒ **Shallow Flow**
  - Length: 253.367
  - Inter. K: 0.619
  - Slope: 2.593
- ☒ **Concentrated Flow**
  - Method: Continuity
  - Length: 0.000
  - Velocity: 5.000
- Accum. Distance: 279.367
- Accum. Avg. Slope: 2.650
- Tc= 2.523** (circled in red)
- Buttons: Compute, Apply

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore **5 must be manually typed** in the Drainage Area Definition dialog after hitting apply in the Time of Concentration Window.

**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area.

Delineate Subareas utilizing the Land Use DGN:



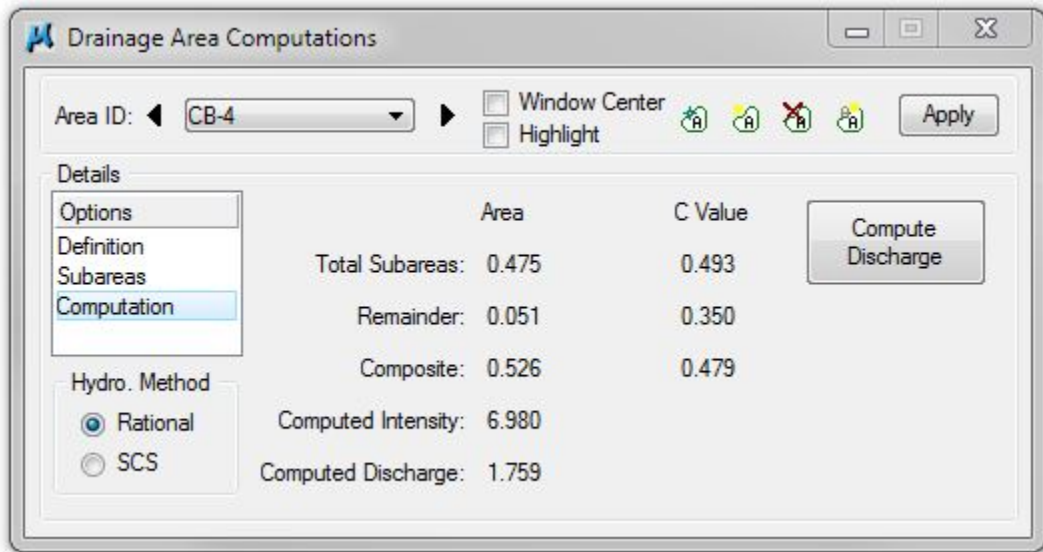
The Drainage Area Subareas dialog box is shown with the following settings:

- Area ID: CB-4
- ☐ Window Center
- ☐ Highlight
- Buttons: Apply
- Details
  - Options
  - Definition
  - Subareas**
  - Computation
- Hydro. Method
  - ☒ Rational
  - ☐ SCS
- To Node ID: CB-4
- Automatic Delineation
- ☒ Display Only
- Table:

Subarea	C Value	Description
0.1524	0.900	Conc./Asphalt Pvmnt
0.3226	0.300	Forested Areas
- 0.323 0.300 Forested Areas



Compute Discharge and Apply:

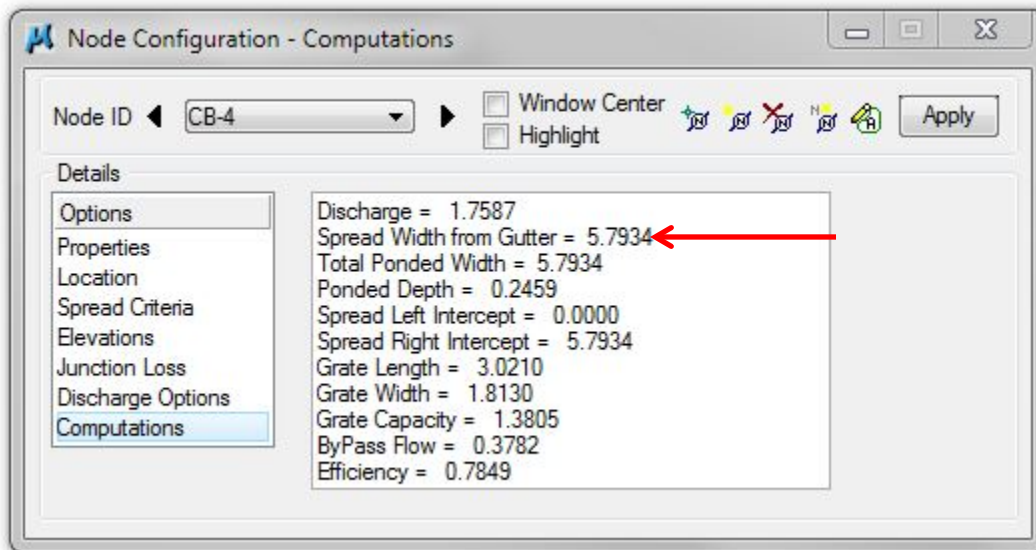


The **Drainage Area Computations** dialog box shows the Area ID as **CB-4**. The **Details** section on the left has **Options**, **Definition**, **Subareas**, and **Computation** (selected). The **Hydro. Method** section has **Rational** (selected) and **SCS**. The main area displays the following data:

	Area	C Value
Total Subareas:	0.475	0.493
Remainder:	0.051	0.350
Composite:	0.526	0.479
Computed Intensity:	6.980	
Computed Discharge:	1.759	

Buttons include **Window Center**, **Highlight**, **Apply**, and **Compute Discharge**.

**Step 3.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



The **Node Configuration - Computations** dialog box shows the Node ID as **CB-4**. The **Details** section on the left has **Options**, **Properties**, **Location**, **Spread Criteria**, **Elevations**, **Junction Loss**, **Discharge Options**, and **Computations** (selected). The main area displays the following data:

Discharge =	1.7587
Spread Width from Gutter =	5.7934
Total Ponded Width =	5.7934
Ponded Depth =	0.2459
Spread Left Intercept =	0.0000
Spread Right Intercept =	5.7934
Grate Length =	3.0210
Grate Width =	1.8130
Grate Capacity =	1.3805
ByPass Flow =	0.3782
Efficiency =	0.7849

Buttons include **Window Center**, **Highlight**, **Apply**, and **Compute Discharge**. A red arrow points to the **Spread Width from Gutter = 5.7934** value.

Don't be alarmed if your results are off by a few 100<sup>th</sup>s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.



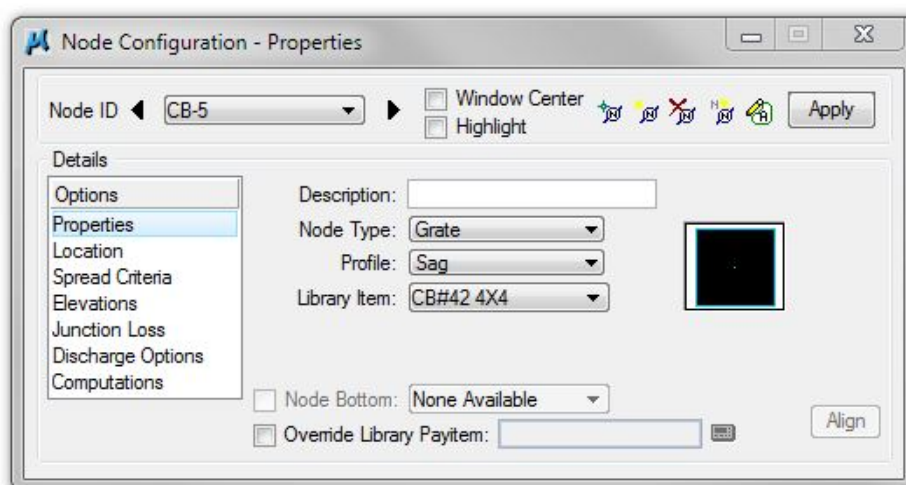
## 5.9 Design Inlet CB – 5

- Step 1.** After a first iteration it has been determined that an area drain needs to be installed behind the curb at **Station 3+70.00, Offset 35.00' RT** in order to catch flow that would otherwise enter the roadway and cause the roadway spread to exceed the allowable limit.

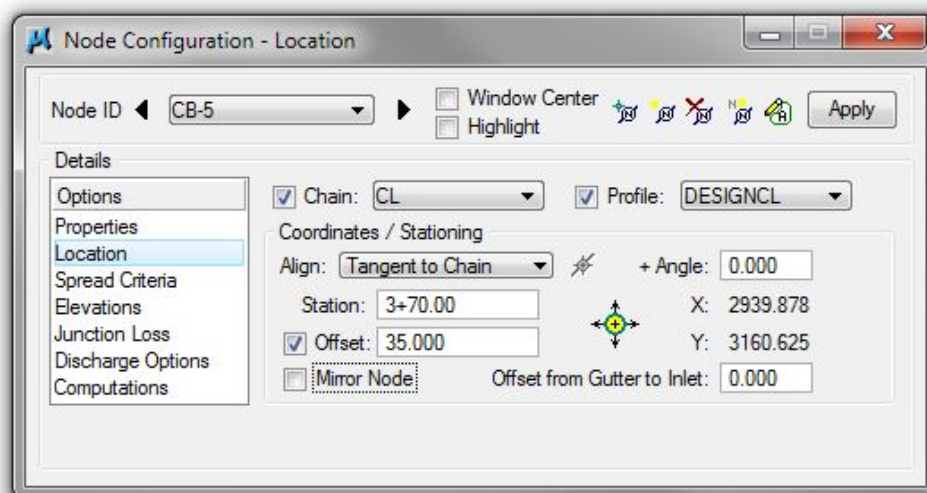
One way to determine the appropriate catch basin to be used is to review [TDOT Drainage Manual Chapter 7](#) Table 7-3 *Standard Inlet Types and Applications*.

It has been determined that a **CB#42 4X4** will be used.

- Step 2.** **Properties > Change Profile to Sag** and change **Library Item** to **CB#42 4X4**:



- Step 3.** **Location > All Reference information is defaulted from the previous Node** such that only the **+Angle**, **Station** and the **Offset** needs to be changed:



**NOTE:** Since CB-5 is an area drain, it does not matter if the angle is 0 or 180, even though it is on the right side of the roadway.

**Step 4. Spread Criteria** > For an inlet in a sag, we must specify certain spread criteria for each side of an inlet.

**% Slope Left:** 1.00 % (From DTM Tools>Analysis>Height/Slope)

**% Slope Right:** 1.00 % (From DTM Tools>Analysis>Height/Slope)

**% Discharge Left:** 98.00% (Estimated based on placement within drainage area)

**% Discharge Right:** 2.00% (Leftover area)

**NOTE:** Left and Right should be defined based on an inlet at angle = 0.

In other words:

Left of inlet is Viewed Left for all inlets at angles <90 and >270.

Right of inlet is Viewed Right for all inlets at angles <90 and >270.

Left of inlet is Viewed Right for all inlets at angles >90 and <270.

Right of inlet is Viewed Left for all inlets at angles >90 and <270.

Node Configuration - Optional Spread Criteria for Sags

Node ID: CB-5

Window Center: ☐ Highlight: ☐

Apply

Details

Options

Properties

Location

Spread Criteria

Elevations

Junction Loss

Discharge Options

Computations

% Slope Left: 1.000 Right: 1.000

% Discharge Left: 98.000 Right: 2.000

Spread Cross Section:

Spread Source: Reference Surface

Width	% Slope	Roughness
2.287	-1.580	0.016
0.063	-6.265	0.016
0.005	-6.265	0.016
0.000	0.000	0.000

Maximum

Pond Depth: 0.500

Pond Width: 8.000

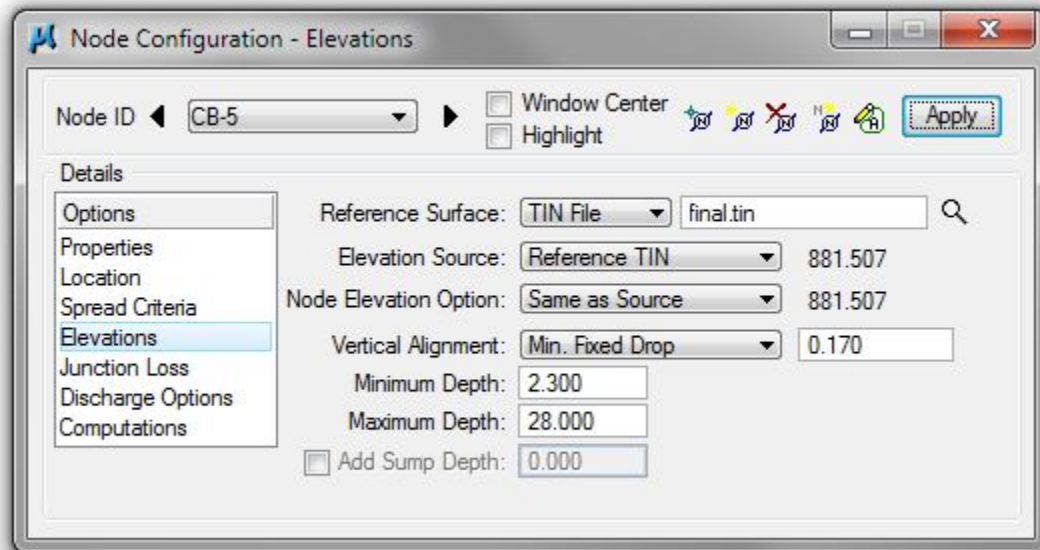
## Exercise 5

**Step 5. Elevations** > Elevation Data must be changed to match a CB#42. From the TDOT GEOPAK Drainage Nodes Document set the following:

**Vertical Alignment:** Min. Fixed Drop, 0.17

**Minimum Depth:** 2.30 feet (See note at top of page 5-7)

**Maximum Depth:** 28.00 feet

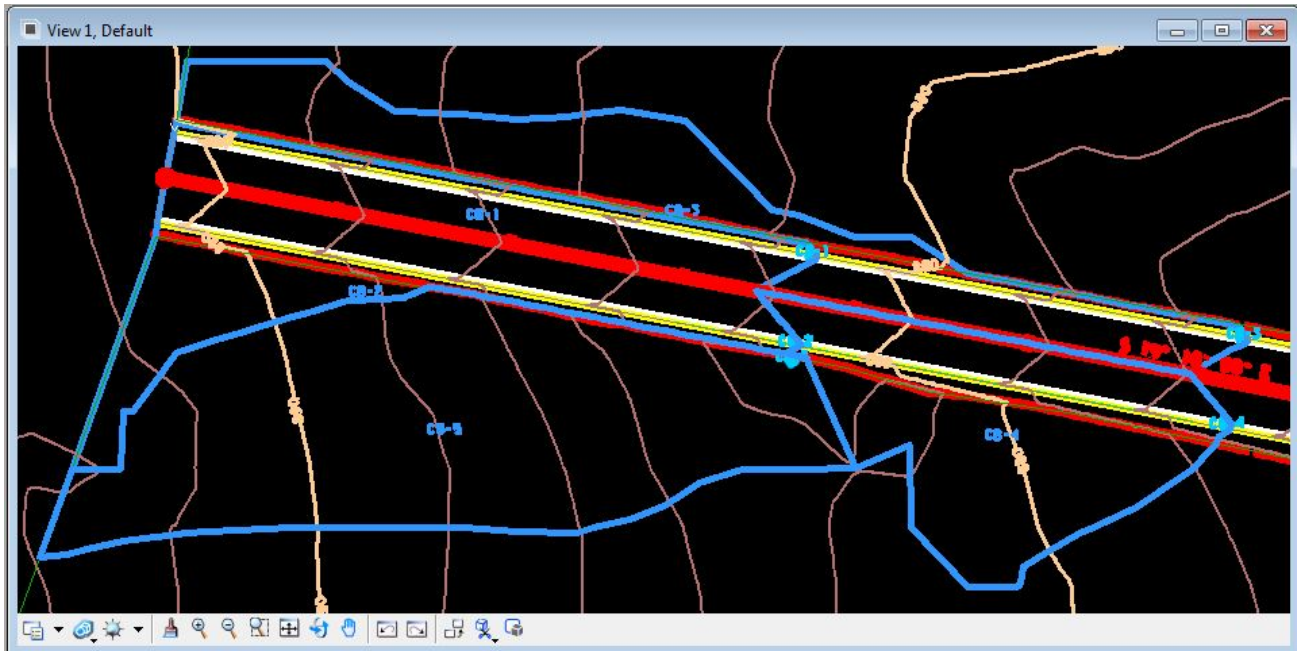


**Step 5.** Click the **Add** button to include this node in the Drainage Project.

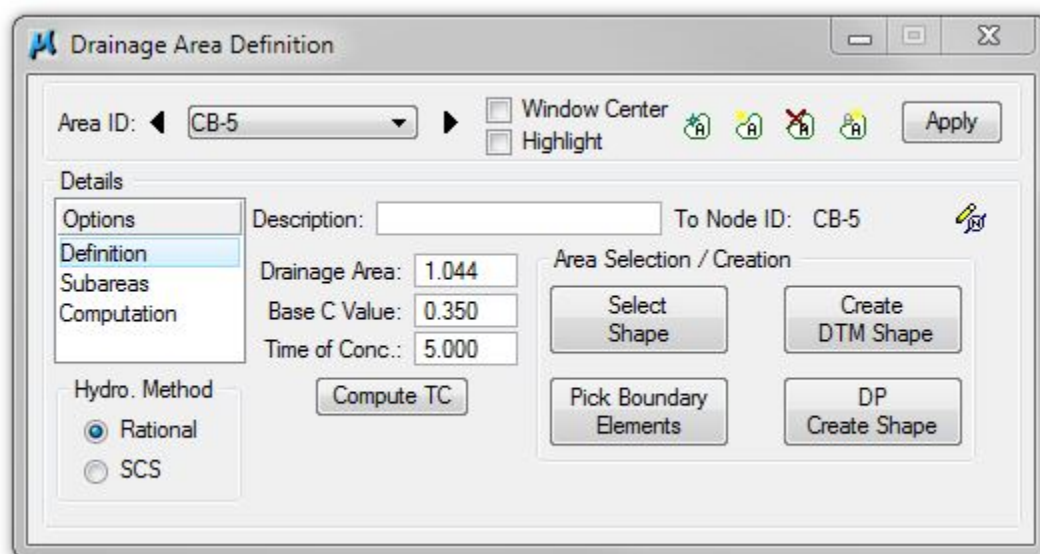
## 5.10 Create Drainage Area CB – 5

- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-5** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 5. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

Delineate Drainage Area:

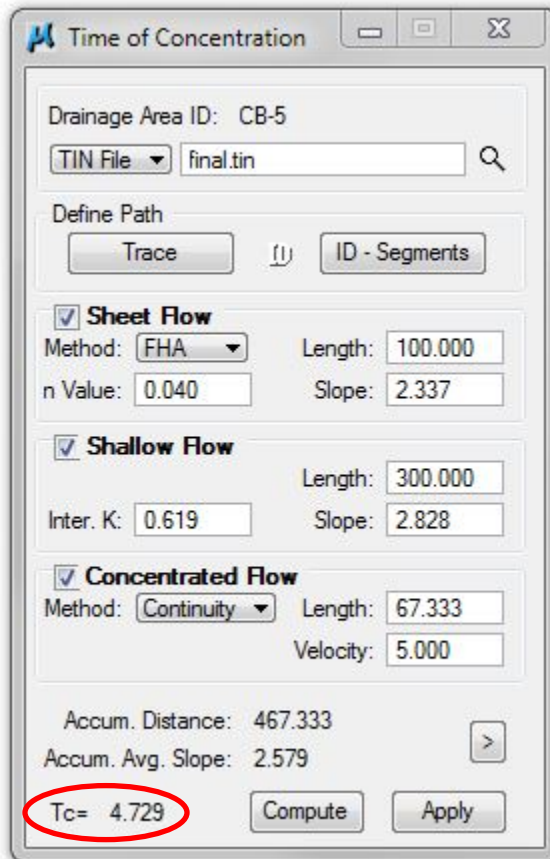


Define Drainage Area:



## Exercise 5

Calculate Time of Concentration:



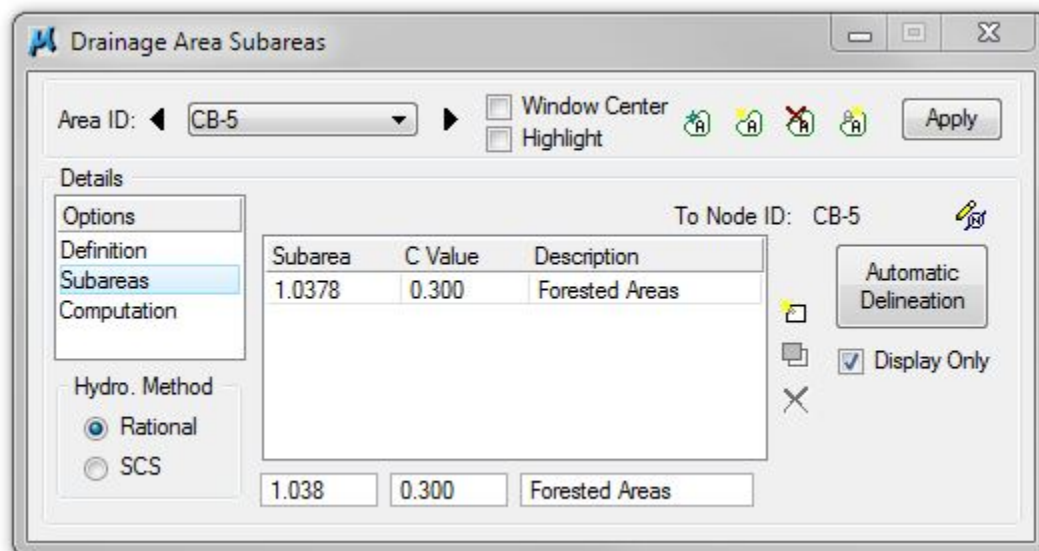
The Time of Concentration dialog box is shown with the following settings:

- Drainage Area ID: CB-5
- TIN File: final.tin
- Define Path: Trace (selected), ID - Segments
- Sheet Flow: ☒ Method: FHA, Length: 100.000, n Value: 0.040, Slope: 2.337
- Shallow Flow: ☒ Inter. K: 0.619, Length: 300.000, Slope: 2.828
- Concentrated Flow: ☒ Method: Continuity, Length: 67.333, Velocity: 5.000
- Accum. Distance: 467.333
- Accum. Avg. Slope: 2.579
- Tc: 4.729 (circled in red)
- Buttons: Compute, Apply

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore **5 must be manually typed** in the Drainage Area Definition dialog after hitting apply in the Time of Concentration Window.

**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area.

Delineate Subareas utilizing the Land Use DGN:



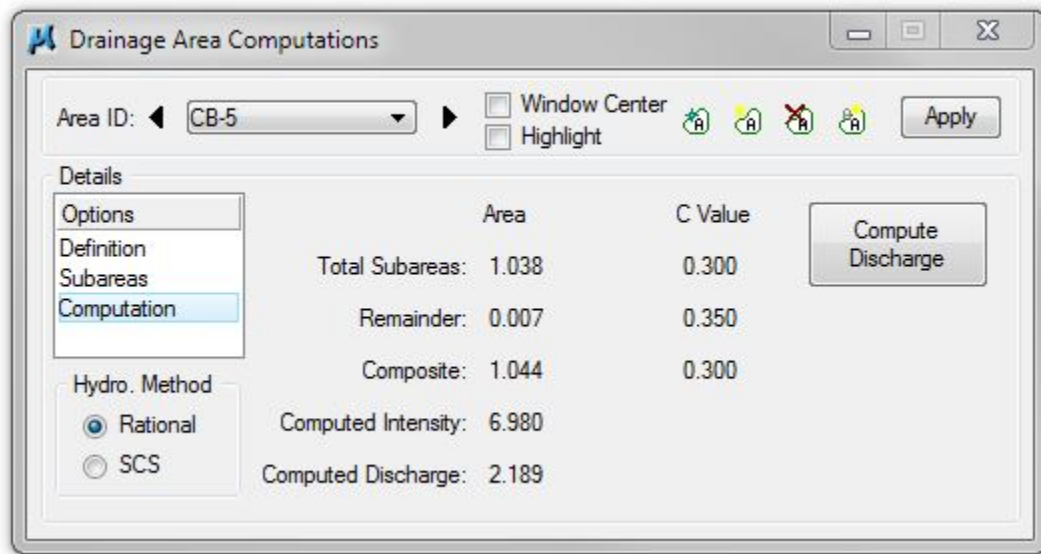
The Drainage Area Subareas dialog box is shown with the following settings:

- Area ID: CB-5
- Window Center: ☐ Highlight: ☐
- Details: Options, Definition, Subareas (selected), Computation
- Hydro. Method: Rational (selected), SCS
- To Node ID: CB-5
- Subarea Table:

Subarea	C Value	Description
1.0378	0.300	Forested Areas
- Buttons: Automatic Delineation, Display Only (checked)



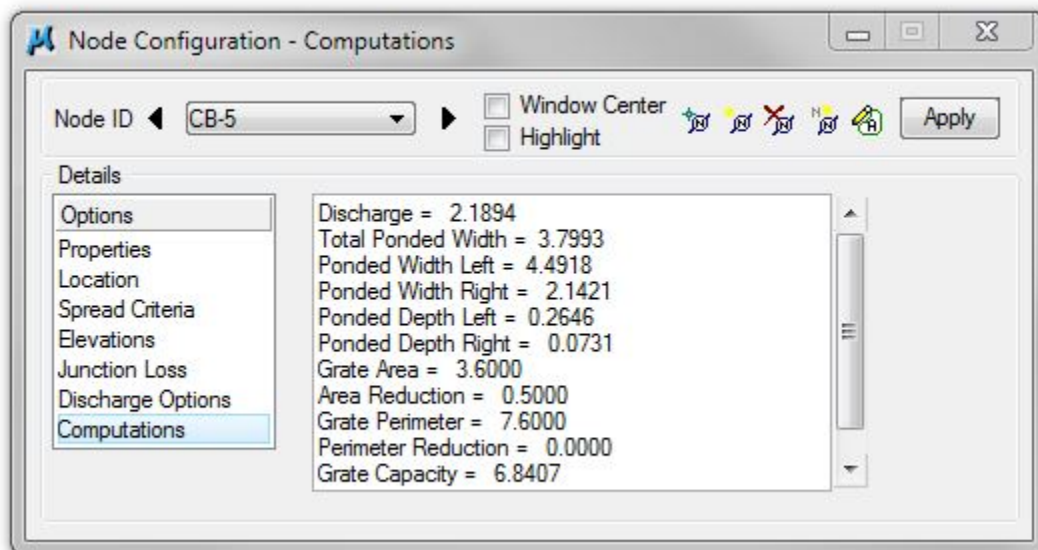
Compute Discharge and Apply:



The 'Drainage Area Computations' dialog box shows the 'Area ID' as 'CB-5'. The 'Details' section on the left has 'Computation' selected. The 'Hydro. Method' section has 'Rational' selected. The 'Compute Discharge' button is visible. The main area displays the following data:

	Area	C Value
Total Subareas:	1.038	0.300
Remainder:	0.007	0.350
Composite:	1.044	0.300
Computed Intensity:	6.980	
Computed Discharge:	2.189	

**Step 3.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



The 'Node Configuration - Computations' dialog box shows the 'Node ID' as 'CB-5'. The 'Details' section on the left has 'Computations' selected. The main area displays the following data:

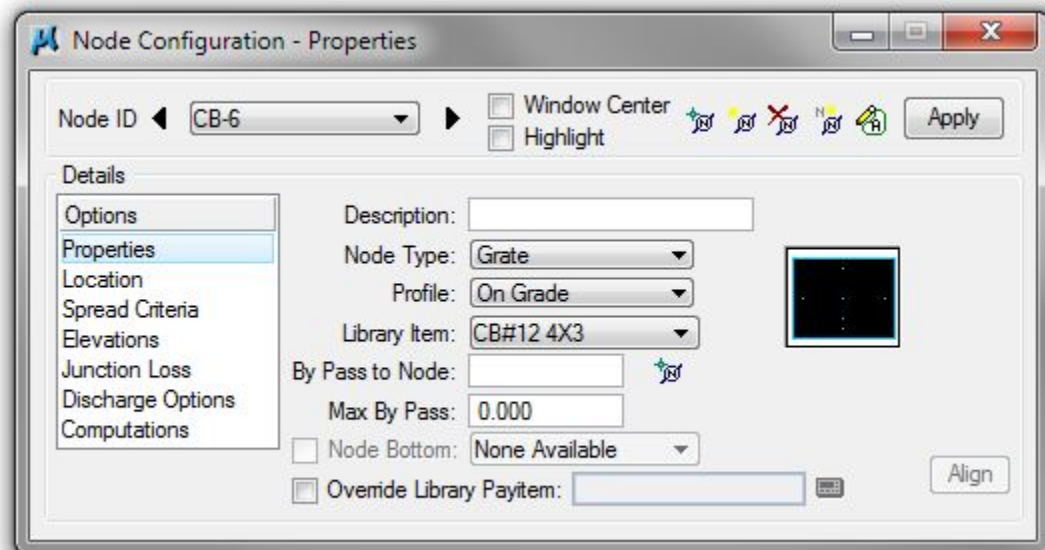
Discharge =	2.1894
Total Ponded Width =	3.7993
Ponded Width Left =	4.4918
Ponded Width Right =	2.1421
Ponded Depth Left =	0.2646
Ponded Depth Right =	0.0731
Gate Area =	3.6000
Area Reduction =	0.5000
Gate Perimeter =	7.6000
Perimeter Reduction =	0.0000
Gate Capacity =	6.8407

Don't be alarmed if your results are off by a few 100<sup>th</sup>s. It could just be a tolerance issue.

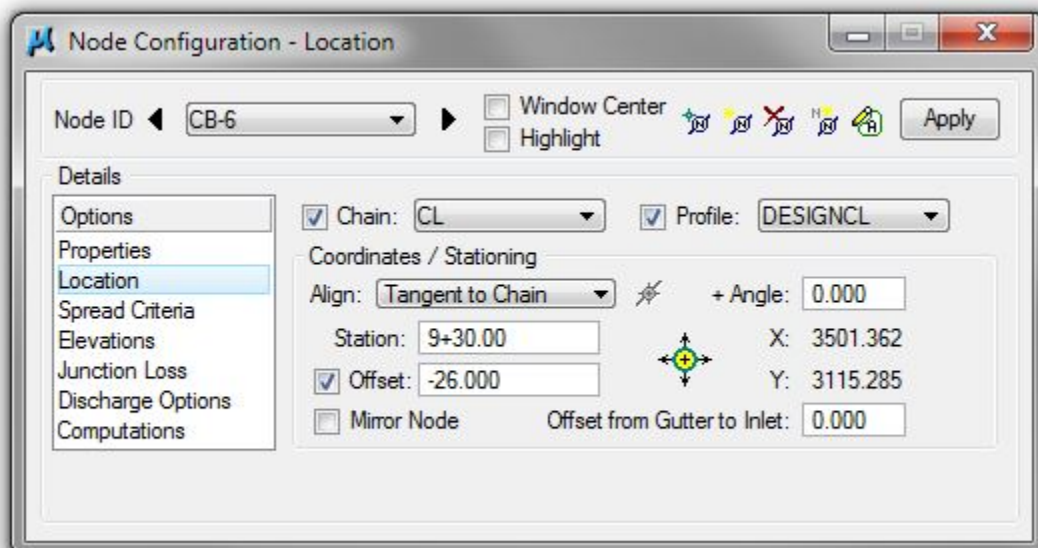
## 5.10 Design Inlet CB – 6

- Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog. Click **OK** to set the name CB-6

**Properties >** Change the Node **Properties** back to **On Grade** and to a **CB#12 4X3**:



- Step 2.** **Location >** All Reference information is defaulted from the previous Node (CB-5) such that only the **+ Angle**, **Station** and the **Offset** needs to be changed. Discussion for the reason this station was chosen is presented in Step 2 of 5.11.:



**NOTE:** The **Spread Criteria** defaults back automatically when the node is changed back to **ON GRADE**, therefore no changes are necessary.

**Step 3. Elevations** > Be sure to change the elevation data back to that which is required for a Type 12 catch basin.

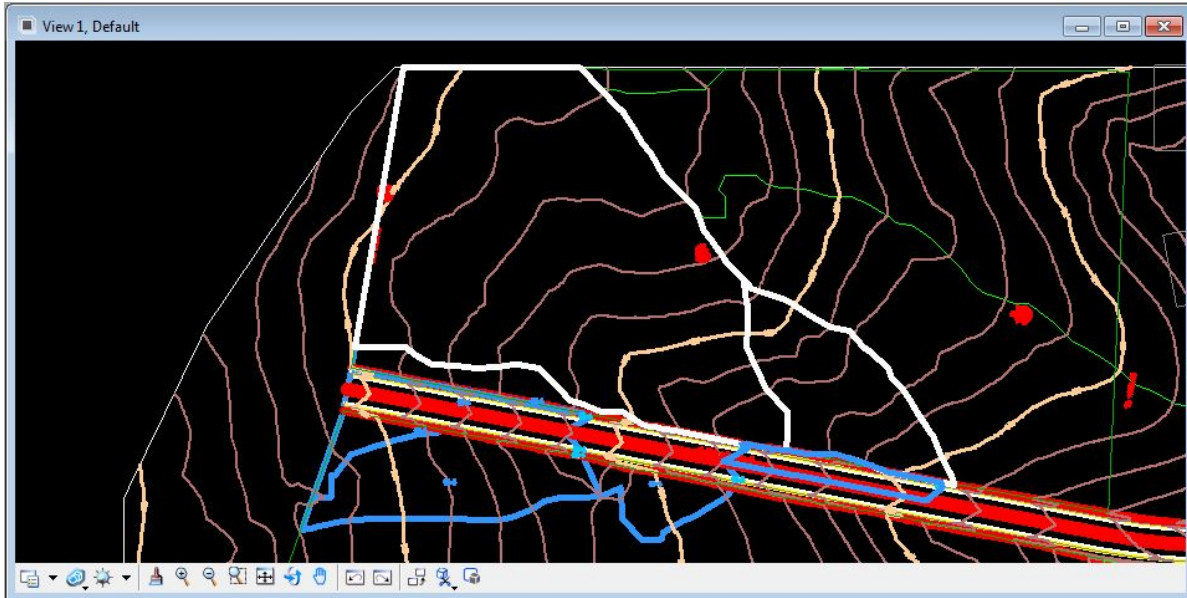
The screenshot shows the 'Node Configuration - Elevations' dialog box. At the top, the 'Node ID' is set to 'CB-6'. There are checkboxes for 'Window Center' and 'Highlight', and an 'Apply' button. Below this is a 'Details' section with a list of options on the left: 'Options', 'Properties', 'Location', 'Spread Criteria', 'Elevations' (which is selected), 'Junction Loss', 'Discharge Options', and 'Computations'. The main area contains the following settings: 'Reference Surface' is 'TIN File' with a file name 'final.tin'; 'Elevation Source' is 'Reference TIN' with a value of 868.548; 'Node Elevation Option' is 'Same as Source' with a value of 868.548; 'Vertical Alignment' is 'Min. Fixed Drop' with a value of 0.170; 'Minimum Depth' is 2.210; 'Maximum Depth' is 20.000; and 'Add Sump Depth' is 0.000 with an unchecked checkbox.

**Step 4.** Click the **Apply** button to include this node in the Drainage Project.

## 5.11 Create Drainage Area CB – 6

- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-6** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 6. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

Delineate Drainage Area:

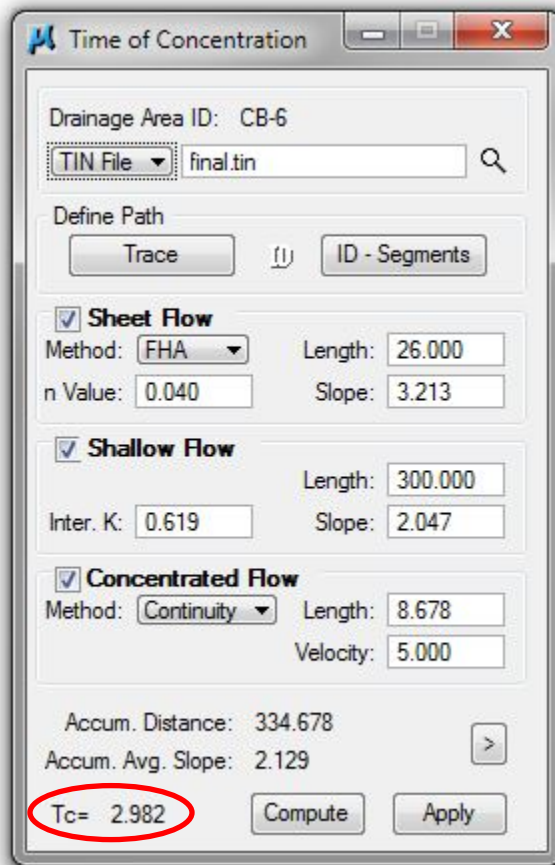


**NOTE:** Upon inspection of the entire drainage area, it has been determined that area drains need to be installed to collect runoff before it enters the roadway. The white area shapes show the area to be collected by these drains which will be input in subsequent exercises.

Define Drainage Area:



Calculate Time of Concentration:



The 'Time of Concentration' dialog box is shown. It includes fields for 'Drainage Area ID' (CB-6), 'TIN File' (final.tin), and 'Define Path' (Trace, ID - Segments). It has three sections for flow types: 'Sheet Flow' (Method: FHA, Length: 26.000, n Value: 0.040, Slope: 3.213), 'Shallow Flow' (Length: 300.000, Inter. K: 0.619, Slope: 2.047), and 'Concentrated Flow' (Method: Continuity, Length: 8.678, Velocity: 5.000). Summary statistics show 'Accum. Distance: 334.678' and 'Accum. Avg. Slope: 2.129'. The 'Tc=' field is circled in red and contains the value 2.982. Buttons for 'Compute' and 'Apply' are at the bottom.

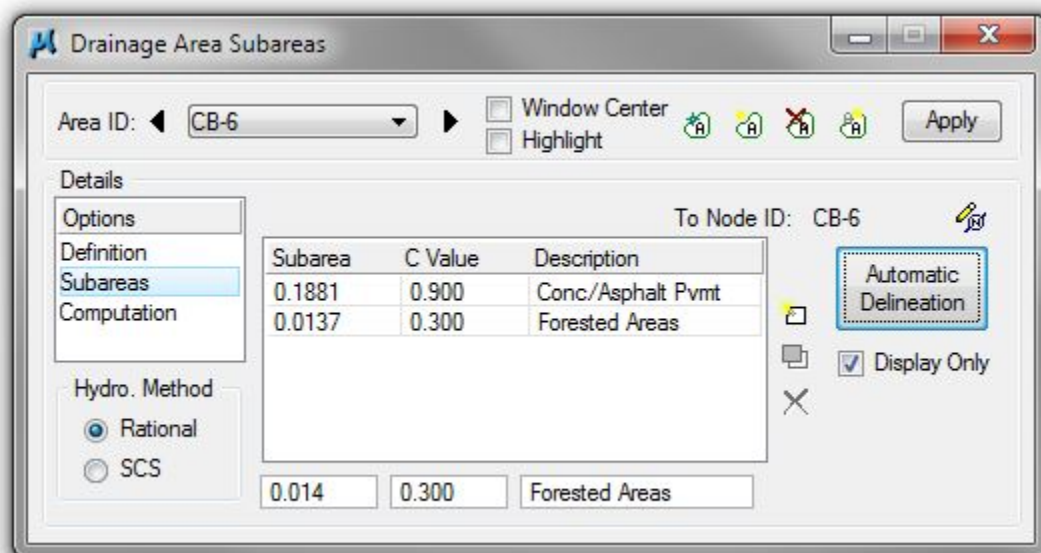
Flow Type	Method	Length	n Value	Slope	Inter. K	Velocity
Sheet Flow	FHA	26.000	0.040	3.213		
Shallow Flow		300.000		2.047	0.619	
Concentrated Flow	Continuity	8.678				5.000

Accum. Distance: 334.678  
Accum. Avg. Slope: 2.129  
**Tc= 2.982**  
Compute Apply

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore **5 must be manually typed** in the Drainage Area Definition dialog after hitting apply in the Time of Concentration Window.

**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area.

Delineate Subareas utilizing the Land Use DGN:



The 'Drainage Area Subareas' dialog box is shown. It includes 'Area ID' (CB-6), 'Window Center' and 'Highlight' checkboxes, and an 'Apply' button. A 'Details' sidebar has 'Subareas' selected. The 'To Node ID' is CB-6. A table lists subareas with their C values and descriptions. The 'Automatic Delineation' button is highlighted. The 'Display Only' checkbox is checked. The 'Hydro. Method' section has 'Rational' selected. A summary row at the bottom shows '0.014', '0.300', and 'Forested Areas'.

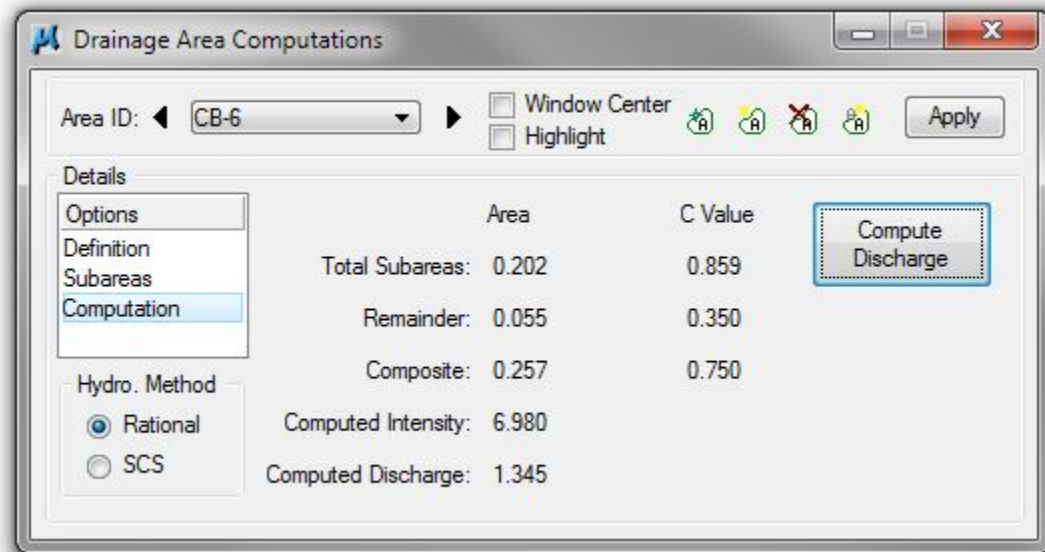
Subarea	C Value	Description
0.1881	0.900	Conc./Asphalt Pvmnt
0.0137	0.300	Forested Areas

Automatic Delineation  
Display Only  
Hydro. Method: Rational  
0.014 0.300 Forested Areas

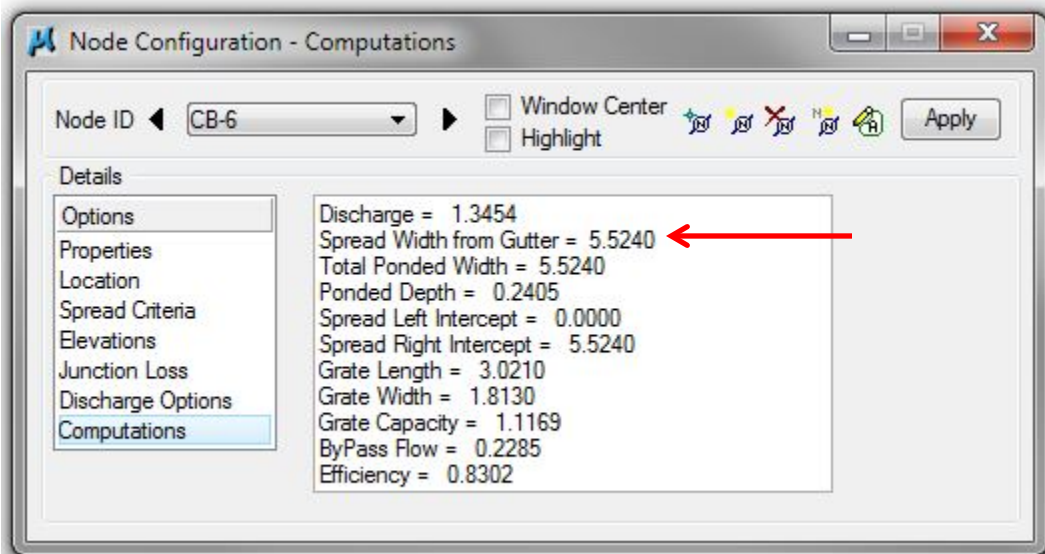


## Exercise 5

Compute Discharge and Apply:



**Step 3.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



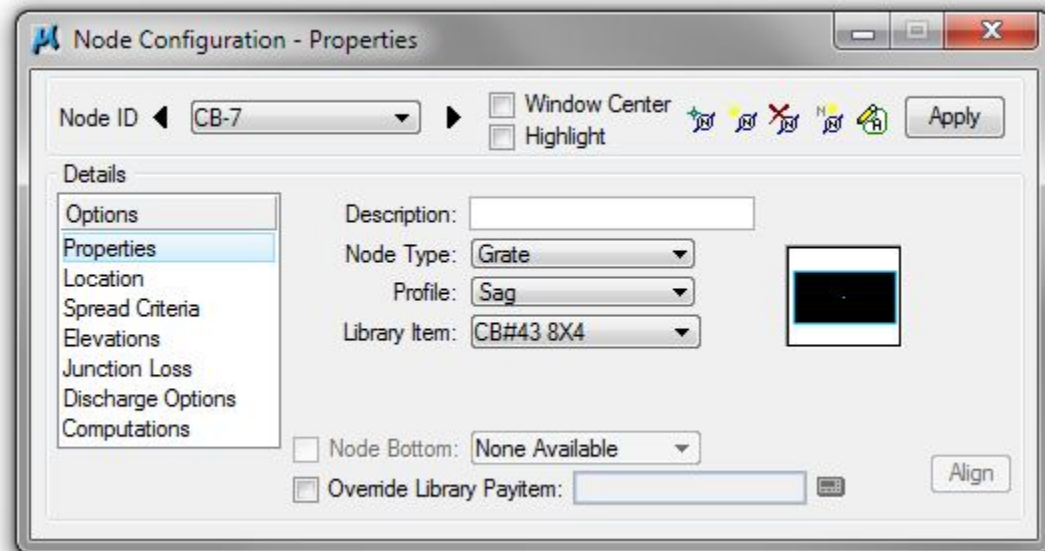
Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

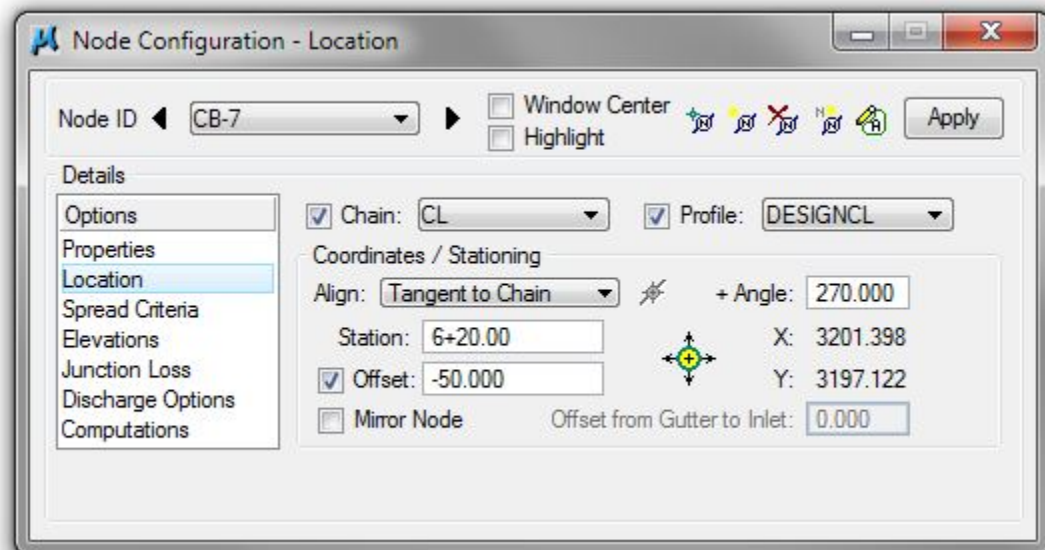
## 5.12 Design Inlet CB – 7

- Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog. Click **OK** to set the name CB-7

**Properties >** Change the Node **Properties** to **Sag** and to a **CB#43 8X4** (a type #43 catch basin was chosen due to the fact that this will collect a significant amount of water not on the roadway):

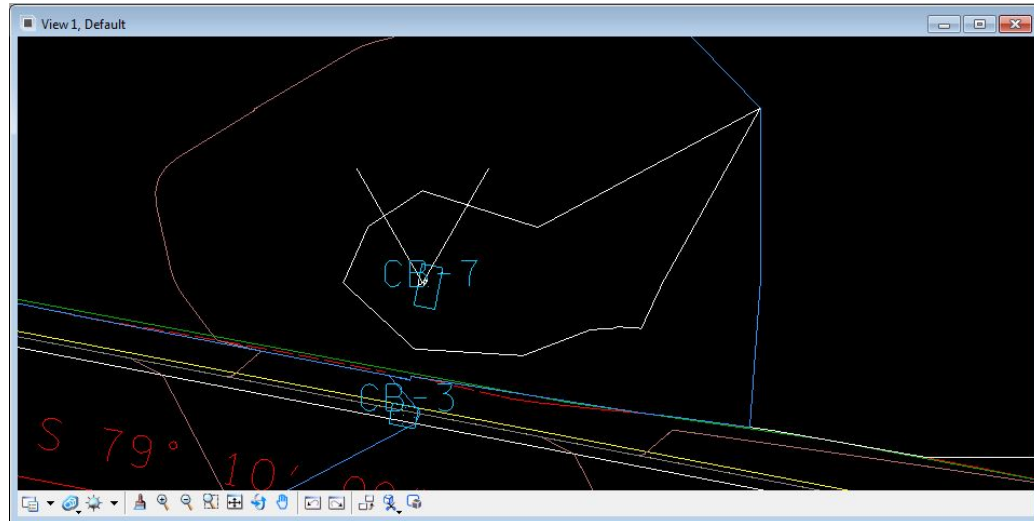


- Step 2.** **Location >** All Reference information is defaulted from the previous Node (CB-6) such that only the **+ Angle**, **Station** and the **Offset** needs to be changed. Pay special attention to the placement and rotation of this catch basin. It has been rotated to intercept as much runoff as possible:



## Exercise 5

**NOTE:** The following image shows why this location was chosen for CB-7. Upon inspection of the TIN File, utilizing the DTM Drainage Tools discussed in Chapter 3, a ponded area was discovered at this location. CB-7 was set at the low point of the ponded area. To simplify the design and minimize land disturbance, CB-3 and CB-4 were set at the same station. **The iterative steps required for this determination were not shown in this manual, but would be required in an actual design project.**



**Step 3. Spread Criteria >** Enter the Spread Criteria as shown below.

**% Slope Left:** 5.00 % (From DTM Tools>Analysis>Height/Slope)

**% Slope Right:** 3.50 % (From DTM Tools>Analysis>Height/Slope)

**% Discharge Left:** 10.00% (Estimated based on placement within drainage area)

**% Discharge Right:** 90.00% (Leftover area)

**NOTE:** Left and Right are defined by a node at angle 0. To gain your bearing, remember this node has been rotated 270 degrees or 90 degrees clockwise.

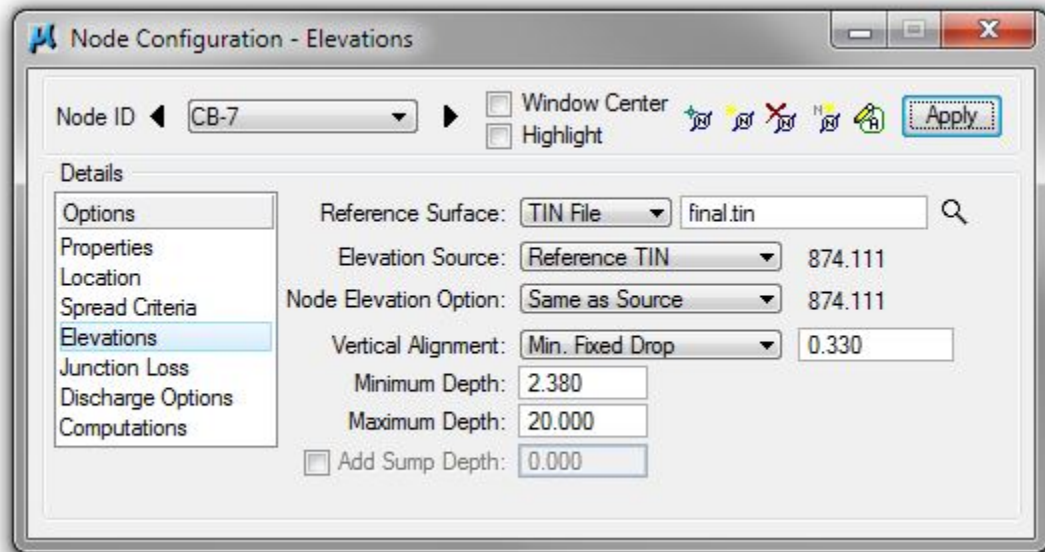
Width	% Slope	Roughness
0.088	2.685	0.016
0.181	4.897	0.016
0.103	4.897	0.016

**Step 4. Elevations** > Elevation Data must be changed to match a CB#43 8x4. From the [TDOT GEOPAK Drainage Nodes](#) Document set the following:

**Vertical Alignment:** Min. Fixed Drop, 0.33

**Minimum Depth:** 2.38 feet (See note at top of page 5-7)

**Maximum Depth:** 20.00 feet



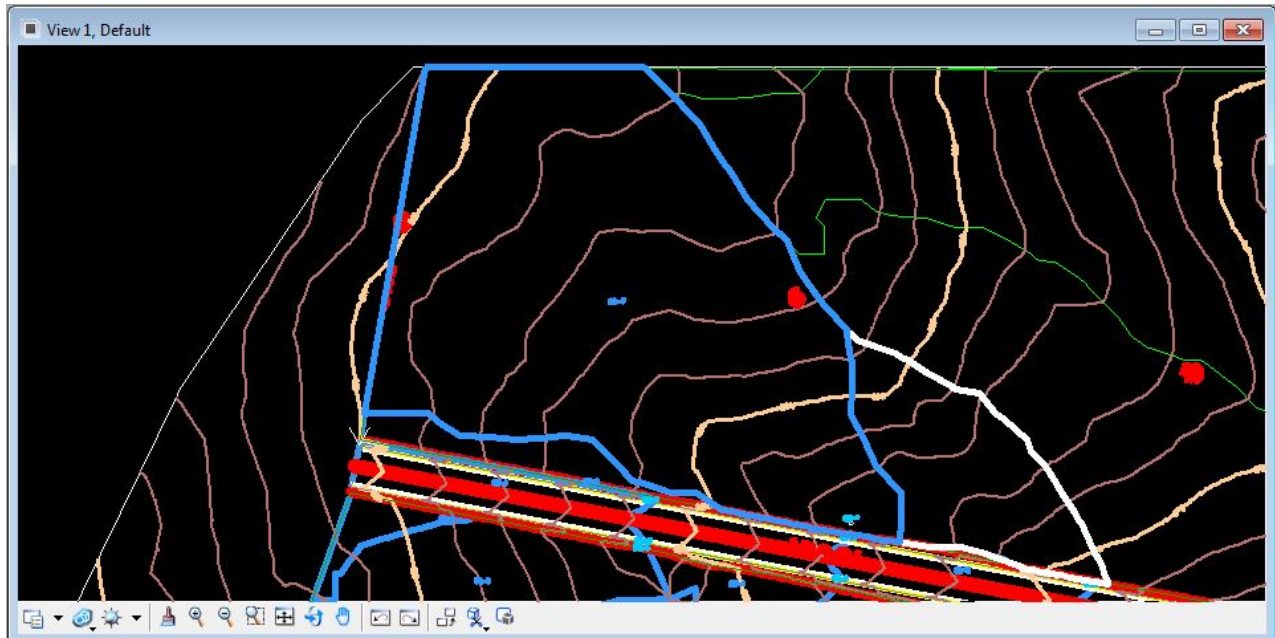
**Step 5.** Click the **Apply** button to include this node in the Drainage Project.



## 5.13 Create Drainage Area CB – 7

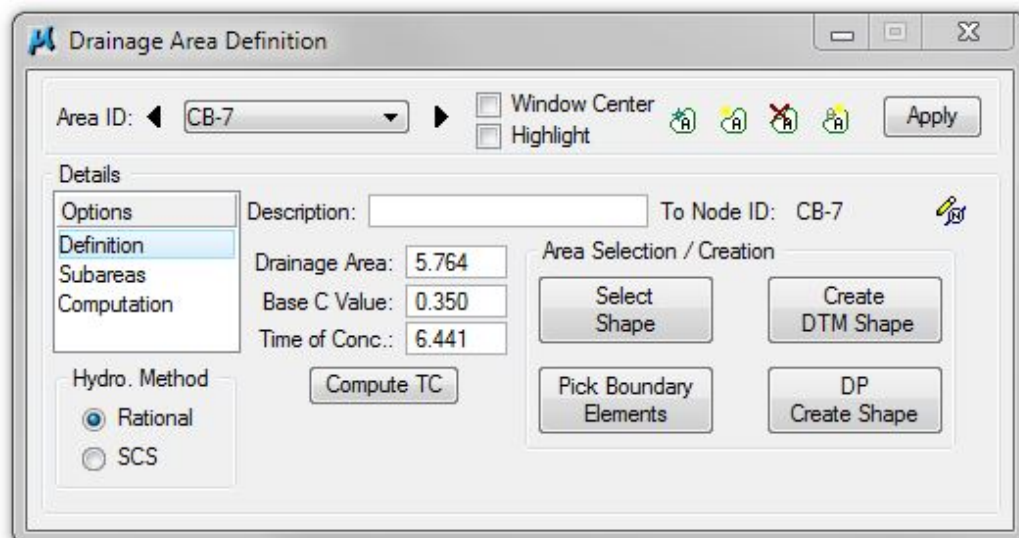
- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-7** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 7. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

Delineate Drainage Area:



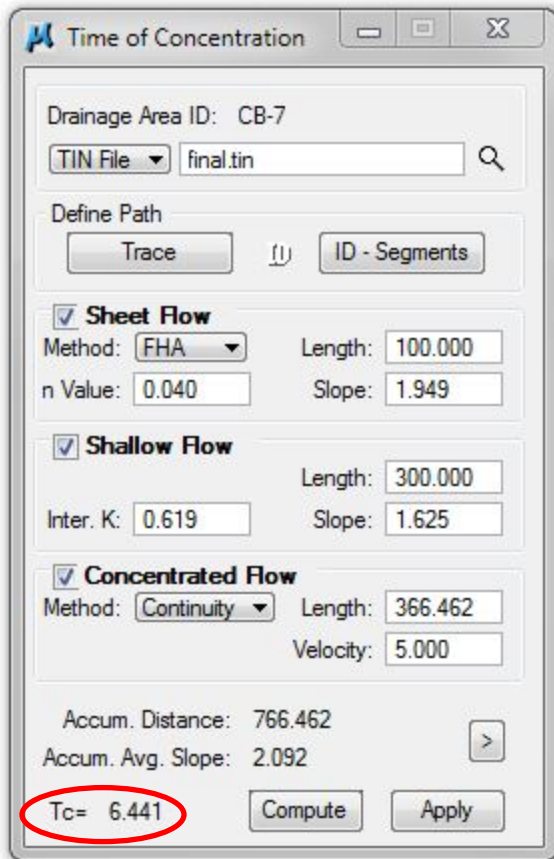
**NOTE:** As discussed in Exercise 5.11 *Create Drainage Area CB-6* this area will catch a large amount of runoff prior to it entering the roadway.

Define Drainage Area:





Calculate Time of Concentration:



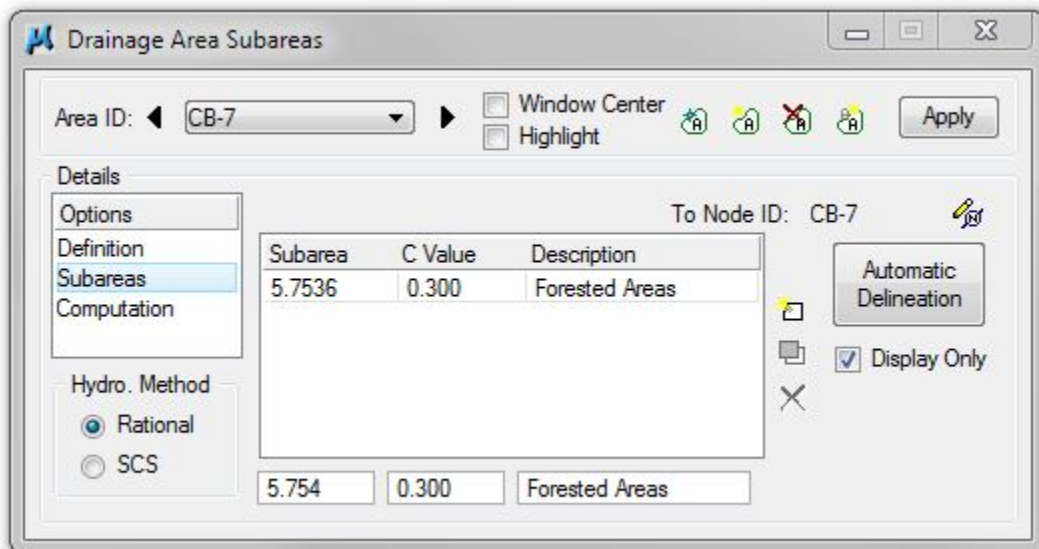
The dialog box is titled "Time of Concentration". It contains the following fields and controls:

- Drainage Area ID: CB-7
- TIN File: final.tin
- Define Path: Trace (disabled), ID - Segments (active)
- ☒ **Sheet Flow**
  - Method: FHA
  - Length: 100.000
  - n Value: 0.040
  - Slope: 1.949
- ☒ **Shallow Flow**
  - Length: 300.000
  - Inter. K: 0.619
  - Slope: 1.625
- ☒ **Concentrated Flow**
  - Method: Continuity
  - Length: 366.462
  - Velocity: 5.000
- Accum. Distance: 766.462
- Accum. Avg. Slope: 2.092
- Tc= 6.441 (circled in red)
- Buttons: Compute, Apply

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required.

**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area.

Delineate Subareas utilizing the Land Use DGN:



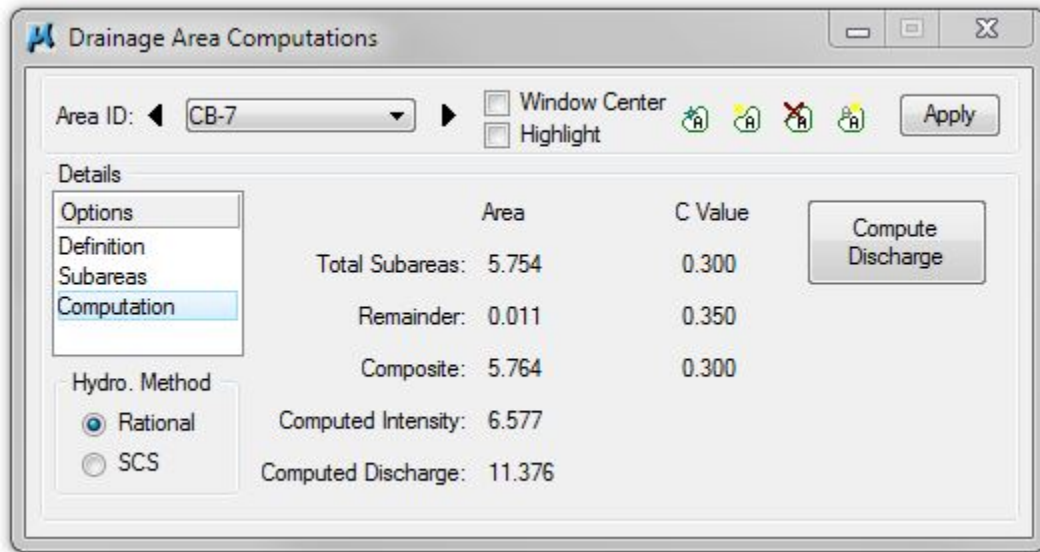
The dialog box is titled "Drainage Area Subareas". It contains the following fields and controls:

- Area ID: CB-7
- Window Center (checkbox)
- Highlight (checkbox)
- Buttons: Apply, Automatic Delineation
- Details
  - Options
  - Definition
  - Subareas (selected)
  - Computation
- Hydro. Method
  - ☒ Rational
  - ☐ SCS
- To Node ID: CB-7
- Table:

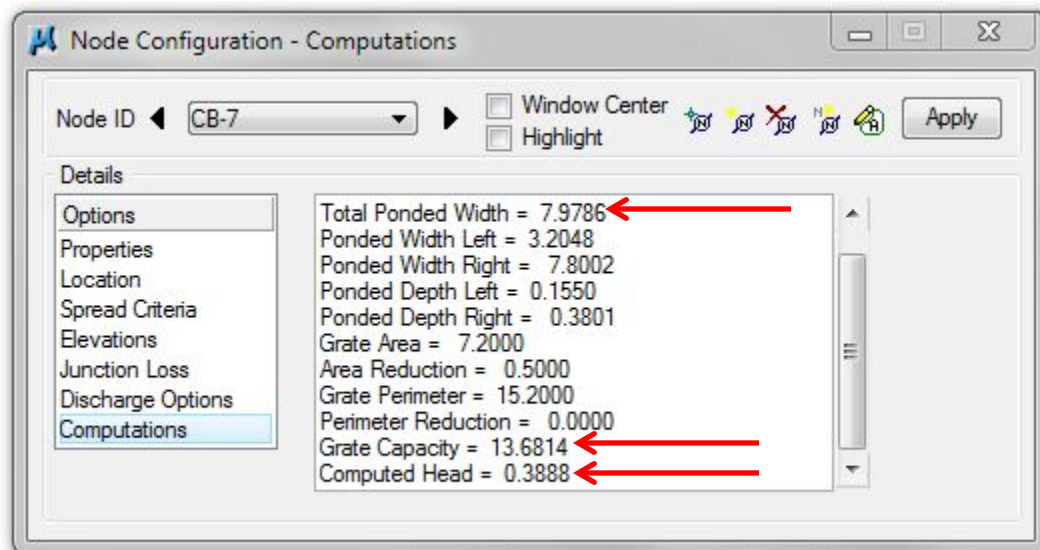
Subarea	C Value	Description
5.7536	0.300	Forested Areas
- Buttons: Automatic Delineation, Display Only (checked), X
- Footer fields: 5.754, 0.300, Forested Areas

## Exercise 5

Compute Discharge and Apply:



**Step 3.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

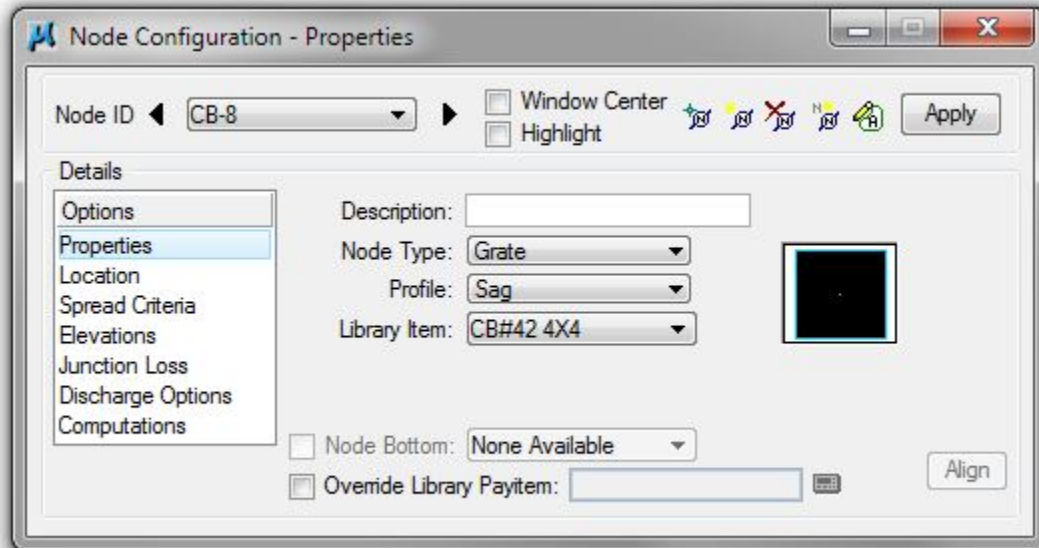
**NOTE:** Review the Computed Data. Items to review specifically are:

**Total Poned Width, Grate Capacity** compared with **Computed Discharge** and **Computed Head**

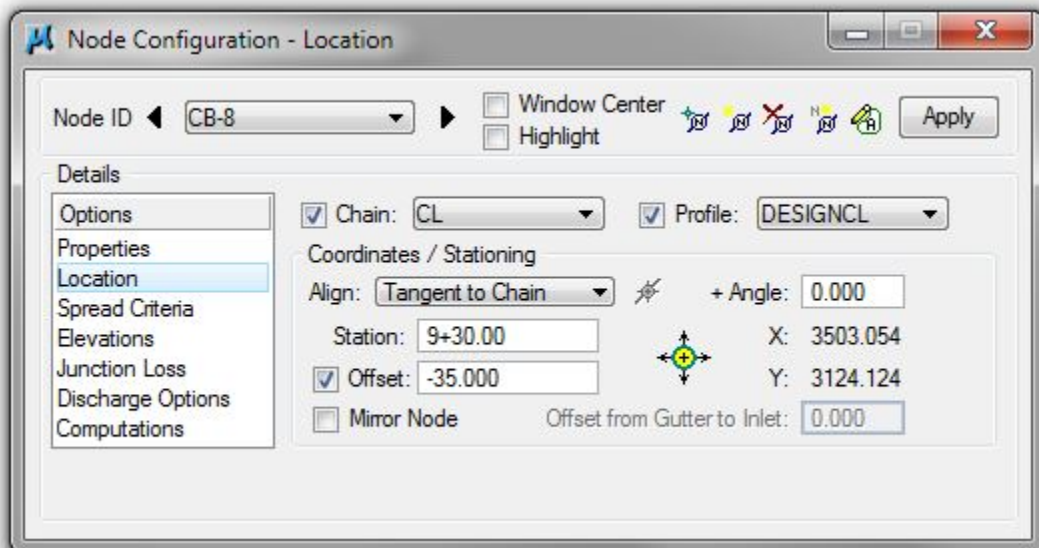
## 5.14 Design Inlet CB – 8

- Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog. Click **OK** to set the name CB-8

**Properties >** Change the Node **Properties** to **Sag** and to a **CB#42 4X4**:



- Step 2.** **Location >** All Reference information is defaulted from the previous Node (CB-7) such that only the **+ Angle**, **Station** and the **Offset** needs to be changed:



## Exercise 5

**Step 3. Spread Criteria** > Enter the Spread Criteria as shown below.

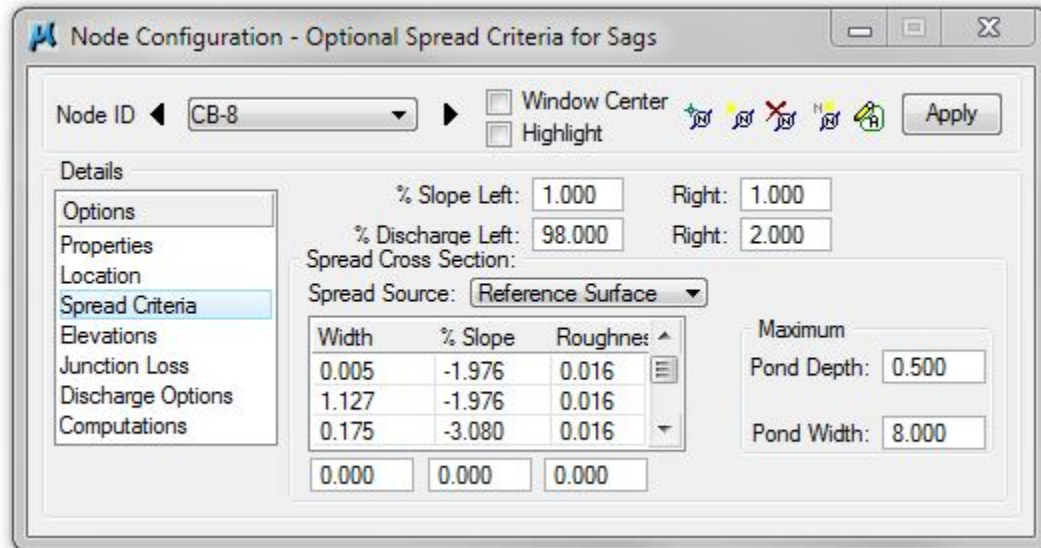
**% Slope Left:** 1.00 % (From DTM Tools>Analysis>Height/Slope)

**% Slope Right:** 1.00 % (From DTM Tools>Analysis>Height/Slope)

**% Discharge Left:** 2.00% (Estimated based on placement within drainage area)

**% Discharge Right:** 98.00% (Leftover area)

**NOTE:** Left and Right are defined by a node at angle 0.



Node ID: CB-8

☐ Window Center ☐ Highlight

Apply

Details

Options  
Properties  
Location  
Spread Criteria  
Elevations  
Junction Loss  
Discharge Options  
Computations

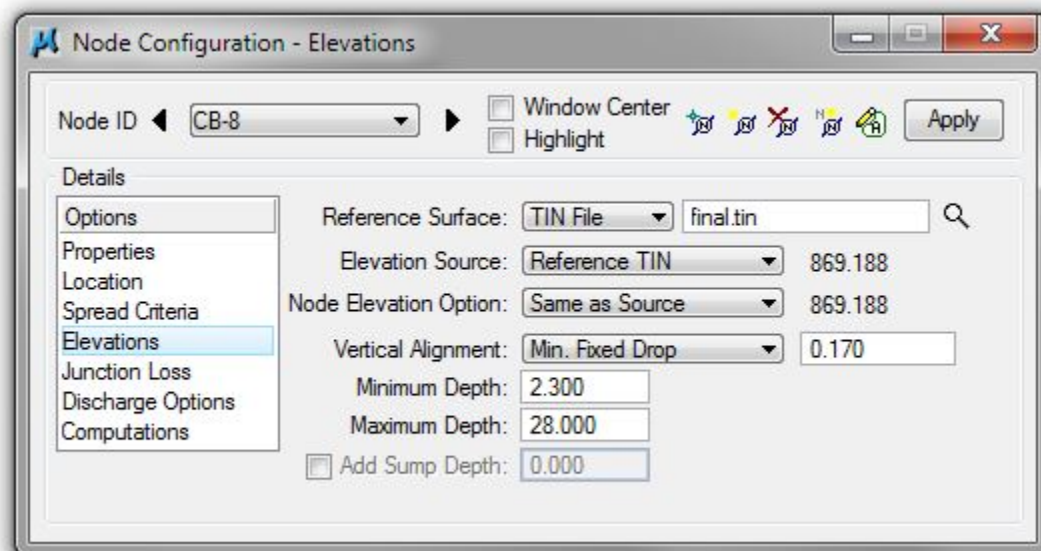
% Slope Left: 1.000 Right: 1.000  
% Discharge Left: 98.000 Right: 2.000

Spread Cross Section:  
Spread Source: Reference Surface

Width	% Slope	Roughness
0.005	-1.976	0.016
1.127	-1.976	0.016
0.175	-3.080	0.016
0.000	0.000	0.000

Maximum  
Pond Depth: 0.500  
Pond Width: 8.000

**Step 4. Elevations** > Elevation Data must be changed to match a CB#42 4X4. From the [TDOT GEOPAK Drainage Nodes](#) Document set the following:



Node ID: CB-8

☐ Window Center ☐ Highlight

Apply

Details

Options  
Properties  
Location  
Spread Criteria  
Elevations  
Junction Loss  
Discharge Options  
Computations

Reference Surface: TIN File final.tin

Elevation Source: Reference TIN 869.188

Node Elevation Option: Same as Source 869.188

Vertical Alignment: Min. Fixed Drop 0.170

Minimum Depth: 2.300

Maximum Depth: 28.000

☐ Add Sump Depth: 0.000

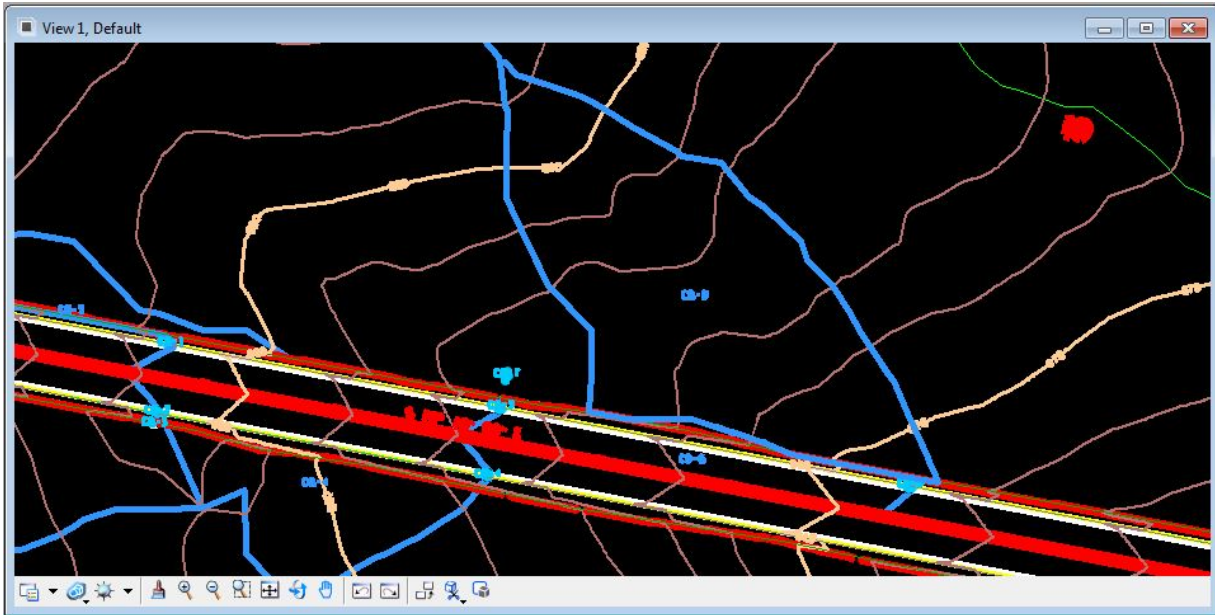
**Step 5.** Click the **Apply** button to include this node in the Drainage Project.



## 5.15 Create Drainage Area CB – 8

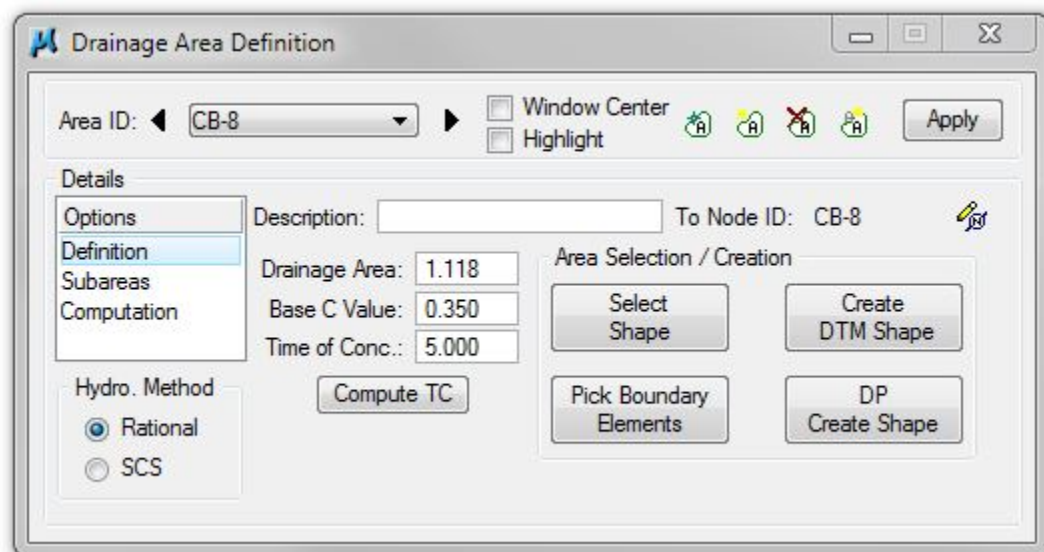
- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-8** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 8. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

Delineate Drainage Area:



**NOTE:** As discussed in Exercise 5.11 *Create Drainage Area CB-6* this area will catch runoff prior to it entering the roadway.

Define Drainage Area:




Drainage Area Definition

Area ID: ◀ CB-8 ▶ ☐ Window Center ☐ Highlight

Details

Options  
Definition  
Subareas  
Computation

Description:  To Node ID: CB-8 

Drainage Area: 1.118  
Base C Value: 0.350  
Time of Conc.: 5.000

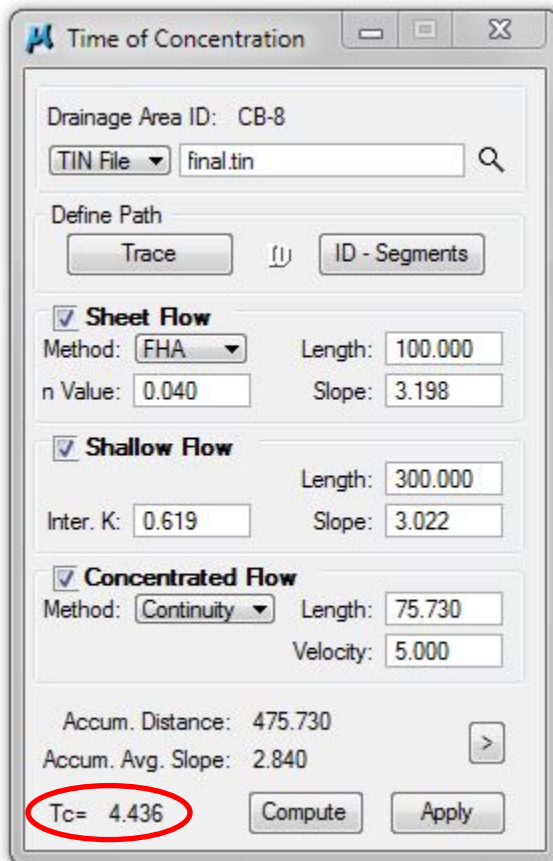
Hydro. Method  
☒ Rational  
☐ SCS

Area Selection / Creation



## Exercise 5

Calculate Time of Concentration:



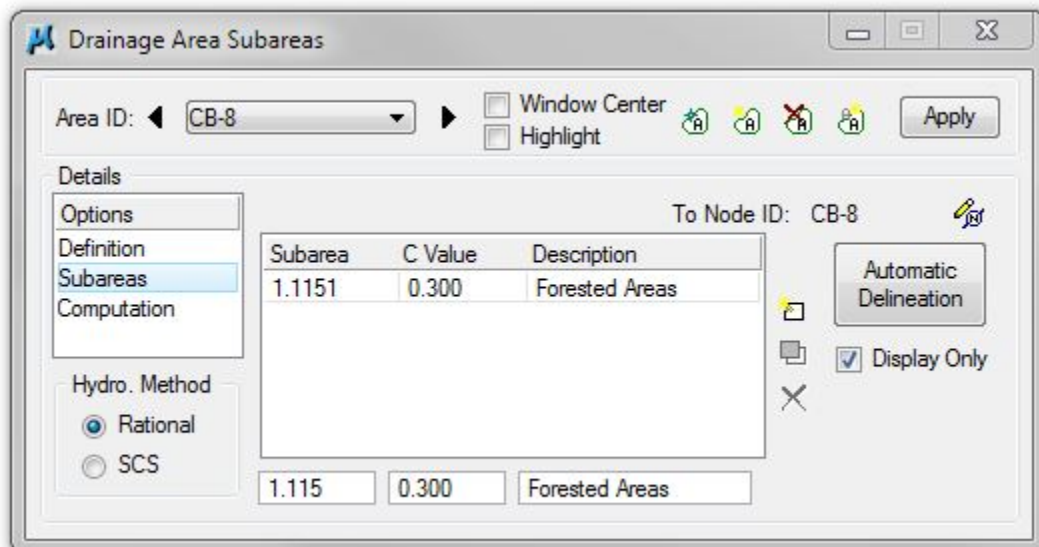
The dialog box is titled "Time of Concentration". It contains the following fields and controls:

- Drainage Area ID: CB-8
- TIN File: final.tin
- Define Path: Trace (disabled), ID - Segments (selected)
- ☒ **Sheet Flow**
  - Method: FHA
  - Length: 100.000
  - n Value: 0.040
  - Slope: 3.198
- ☒ **Shallow Flow**
  - Length: 300.000
  - Inter. K: 0.619
  - Slope: 3.022
- ☒ **Concentrated Flow**
  - Method: Continuity
  - Length: 75.730
  - Velocity: 5.000
- Accum. Distance: 475.730
- Accum. Avg. Slope: 2.840
- Tc= 4.436** (circled in red)
- Buttons: Compute, Apply

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore **5 must be manually typed** in the Drainage Area Definition dialog after hitting apply in the Time of Concentration Window.

**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area.

Delineate Subareas utilizing the Land Use DGN:



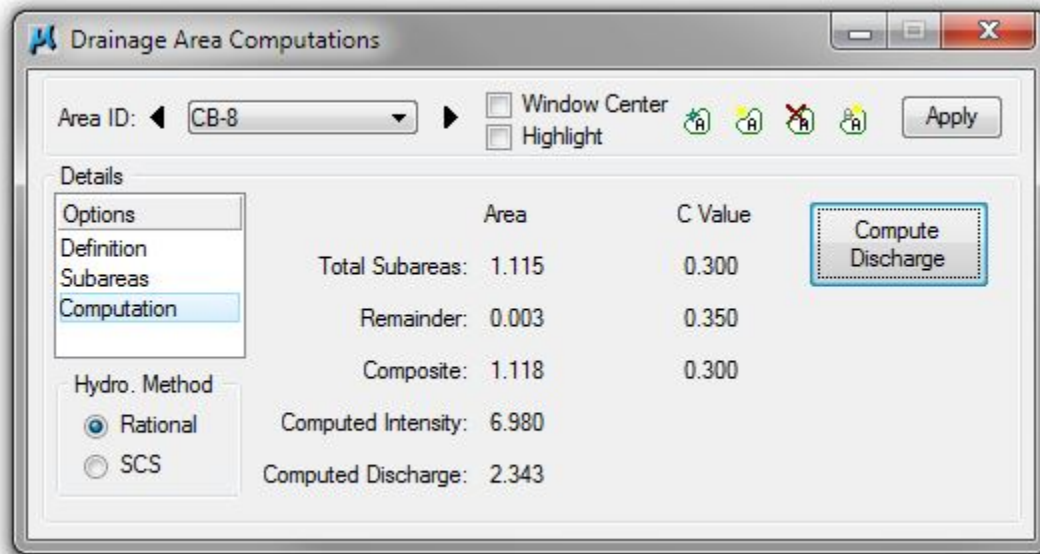
The dialog box is titled "Drainage Area Subareas". It contains the following fields and controls:

- Area ID: CB-8
- Window Center (checkbox)
- Highlight (checkbox)
- Apply button
- Details section with a list box containing: Options, Definition, **Subareas** (selected), Computation
- Hydro. Method: Rational (selected), SCS
- To Node ID: CB-8
- Automatic Delineation button
- Display Only (checkbox, checked)
- Table with 3 columns: Subarea, C Value, Description

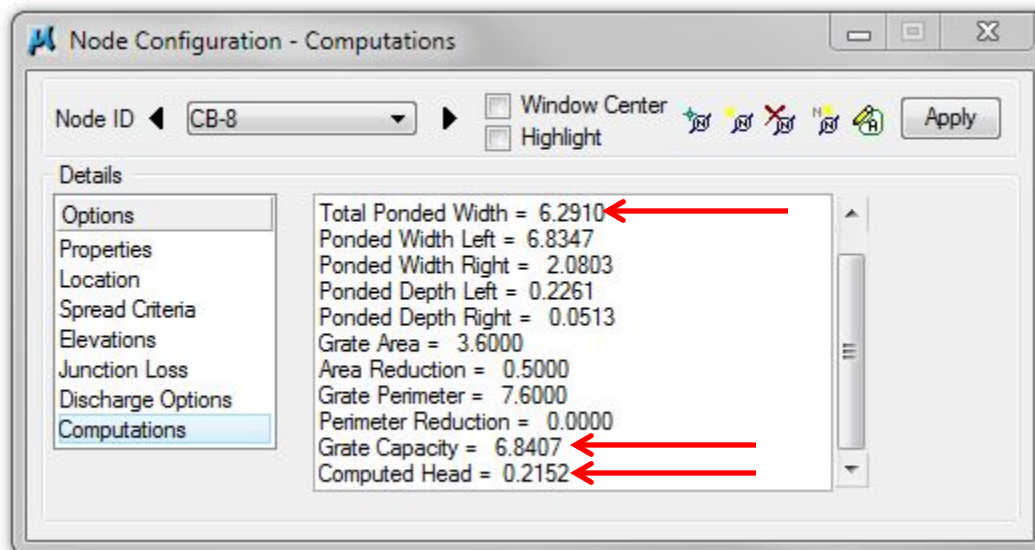
Subarea	C Value	Description
1.1151	0.300	Forested Areas

Below the table, there are input fields for the first row: 1.115, 0.300, and Forested Areas.

Compute Discharge and Apply:



**Step 3.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



Don't be alarmed if you results are off by a few 100<sup>th</sup>s. It could just be a tolerance issue.

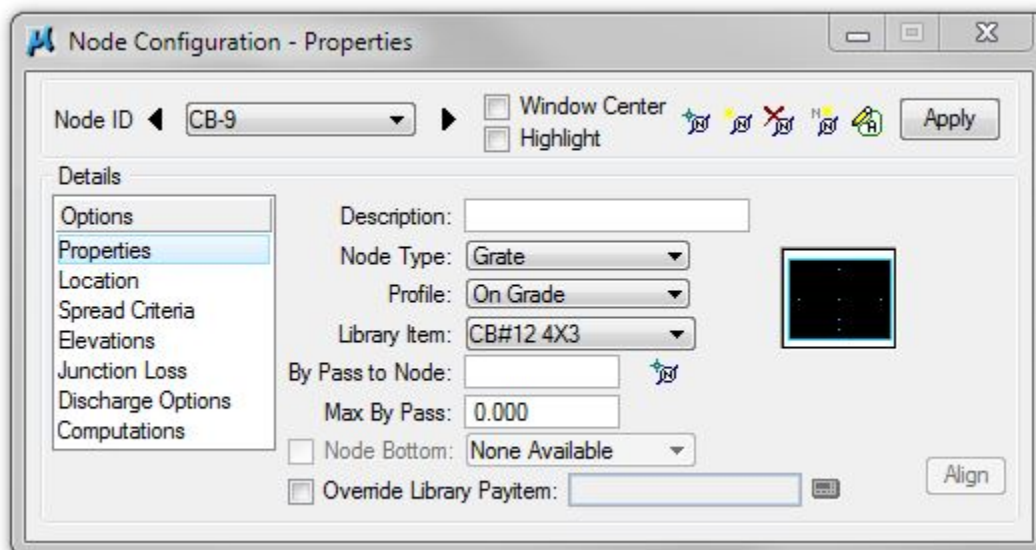
**NOTE:** Review the Computed Data. Items to review specifically are:

**Total Poned Width, Grate Capacity** compared with **Computed Discharge** and **Computed Head**

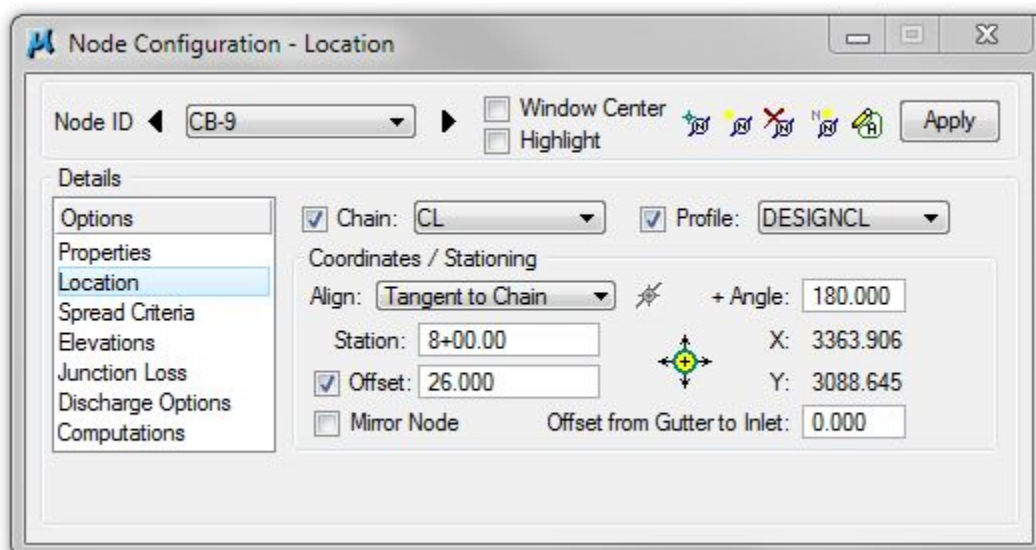
## 5.16 Design Inlet CB – 9

**Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog. Click **OK** to set the name CB-9

**Properties >** Change the Node **Properties** to **On Grade** and to a **CB#12 4X3**:



**Step 2.** **Location >** All Reference information is defaulted from the previous Node (CB-8) such that only the **+ Angle**, **Station** and the **Offset** needs to be changed. The reasoning for the location of CB-9 will be given in the drainage area discussion:



**NOTE:** The **Spread Criteria** defaults back automatically when the node is changed back to **ON GRADE**, therefore no changes are necessary.

**Step 3. Elevations** > Elevation Data must be changed to match a CB#12 4X3. From the [TDOT GEOPAK Drainage Nodes](#) Document set the following:

The screenshot shows the 'Node Configuration - Elevations' dialog box. At the top, the 'Node ID' is set to 'CB-9'. To the right of the Node ID are checkboxes for 'Window Center' and 'Highlight', along with several small icons and an 'Apply' button. Below this is a 'Details' section with a list of options on the left: 'Options', 'Properties', 'Location', 'Spread Criteria', 'Elevations' (which is highlighted), 'Junction Loss', 'Discharge Options', and 'Computations'. To the right of the list are several input fields: 'Reference Surface' is set to 'TIN File' with a file name 'final.tin'; 'Elevation Source' is set to 'Reference TIN' with a value of '870.780'; 'Node Elevation Option' is set to 'Same as Source' with a value of '870.780'; 'Vertical Alignment' is set to 'Min. Fixed Drop' with a value of '0.170'; 'Minimum Depth' is set to '2.210'; 'Maximum Depth' is set to '20.000'; and 'Add Sump Depth' is set to '0.000' with an unchecked checkbox.

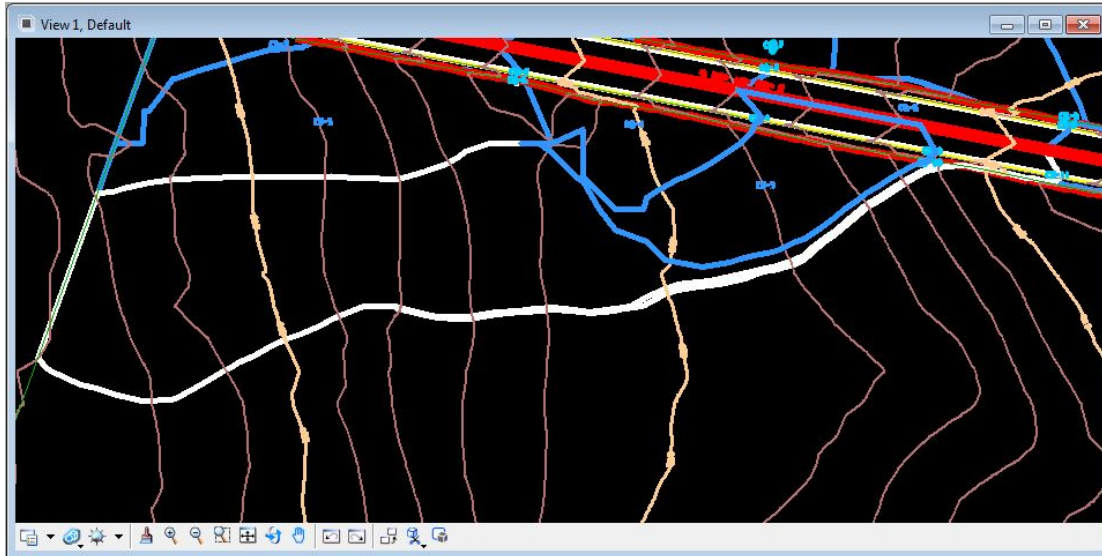
**Step 4.** Click the **Apply** button to include this node in the Drainage Project.



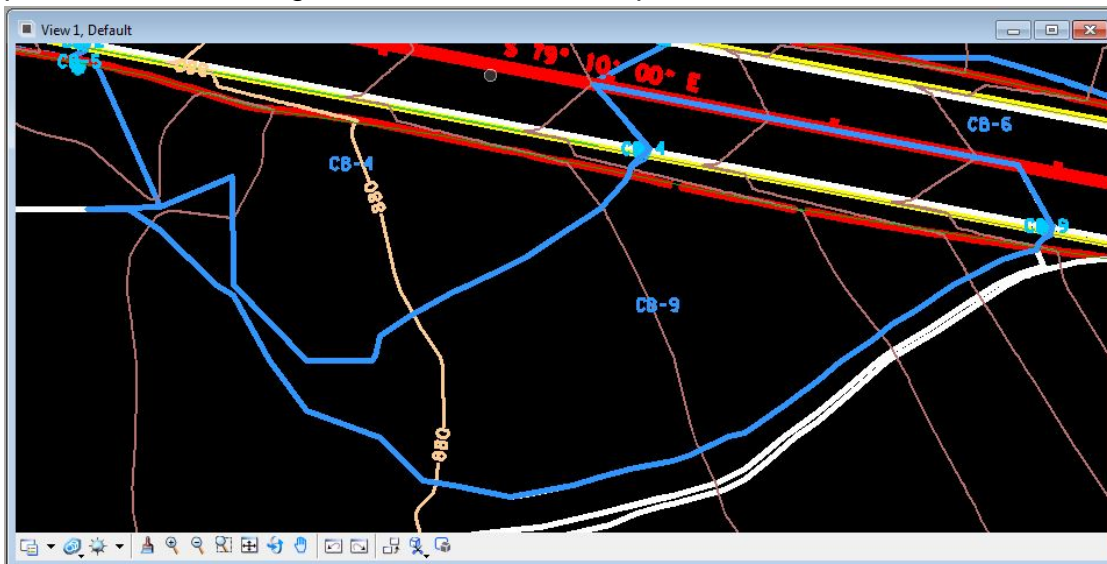
### 5.17 Create Drainage Area CB – 9

- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-9** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 9. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

Delineate Drainage Area:

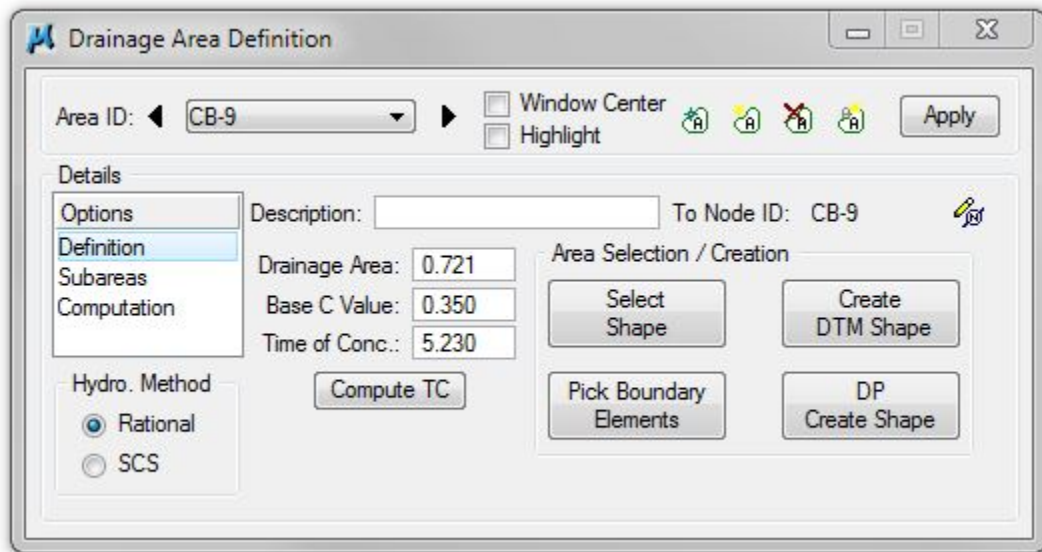


**NOTE:** Many iterations and much investigation went into developing the placement of the next few catch basins. The whole of the drainage area if one were to set CB-9 at the same station as CB-6 & CB-8 is delineated by CB-9 Area and the white drainage area. These were divided to keep the roadway spread within the required limits. The large portion of the drainage area and the odd shape will be discussed in Exercise 5.19.



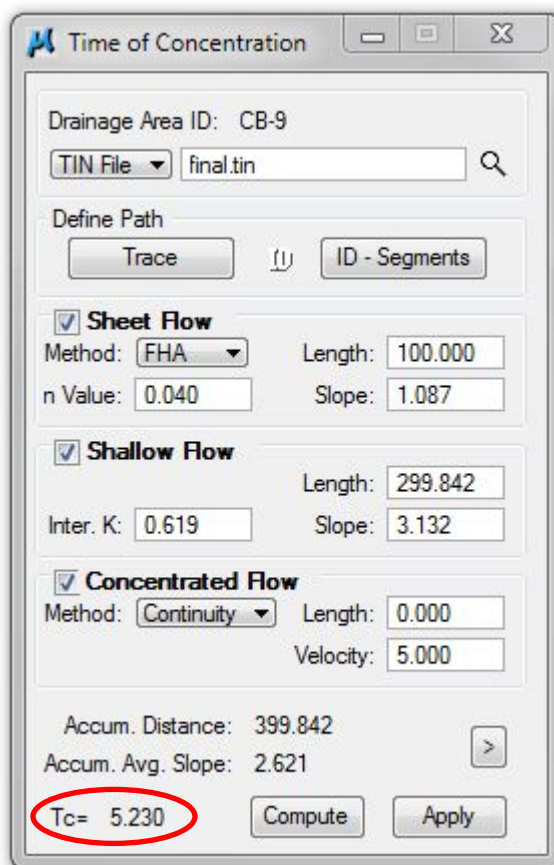


Define Drainage Area:



The 'Drainage Area Definition' dialog box is shown. It features a title bar with a logo and standard window controls. The main area includes a dropdown for 'Area ID' set to 'CB-9', checkboxes for 'Window Center' and 'Highlight', and an 'Apply' button. A 'Details' section on the left has a tree view with 'Options', 'Definition' (selected), 'Subareas', and 'Computation'. The 'Definition' section contains fields for 'Description', 'To Node ID' (set to 'CB-9'), 'Drainage Area' (0.721), 'Base C Value' (0.350), and 'Time of Conc.' (5.230). There is a 'Compute TC' button. The 'Area Selection / Creation' section on the right includes buttons for 'Select Shape', 'Create DTM Shape', 'Pick Boundary Elements', and 'DP Create Shape'. At the bottom left, there are radio buttons for 'Hydro. Method' with 'Rational' selected and 'SCS' unselected.

Calculate Time of Concentration:



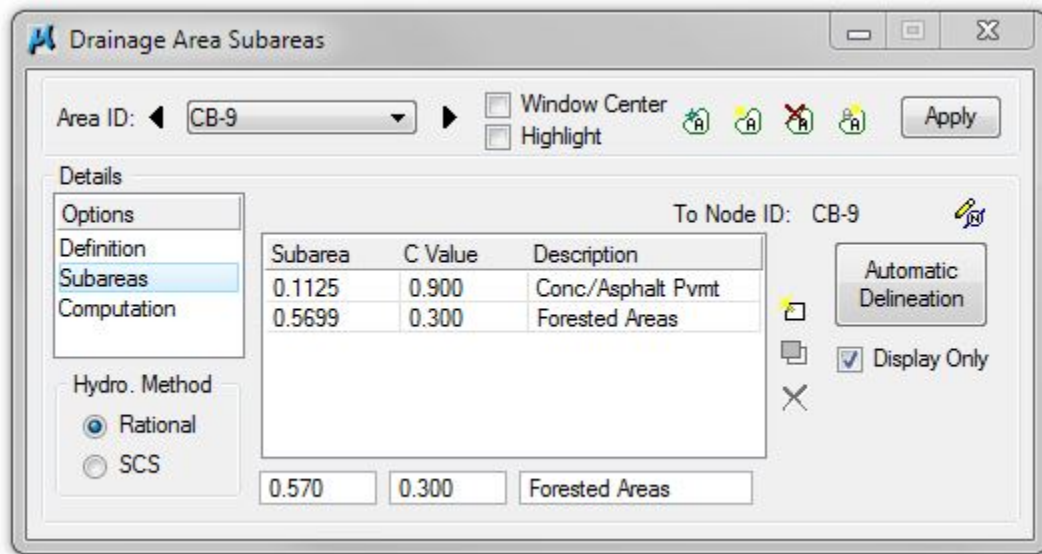
The 'Time of Concentration' dialog box is shown. It has a title bar with a logo and standard window controls. The 'Drainage Area ID' is set to 'CB-9'. There is a 'TIN File' dropdown set to 'final.tin' with a search icon. The 'Define Path' section has 'Trace' and 'ID - Segments' buttons. Three flow methods are checked: 'Sheet Flow' (Method: 'FHA', Length: 100.000, n Value: 0.040, Slope: 1.087), 'Shallow Flow' (Length: 299.842, Inter. K: 0.619, Slope: 3.132), and 'Concentrated Flow' (Method: 'Continuity', Length: 0.000, Velocity: 5.000). At the bottom, 'Accum. Distance' is 399.842 and 'Accum. Avg. Slope' is 2.621. The 'Tc=' field is circled in red and shows the value 5.230. There are 'Compute' and 'Apply' buttons.

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required.

**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area.

## Exercise 5

Delineate Subareas utilizing the Land Use DGN:



The **Drainage Area Subareas** dialog box is shown. The **Area ID** is set to **CB-9**. The **Details** tab is selected, showing a table of subareas. The **Hydro. Method** is set to **Rational**. The **Window Center** and **Highlight** checkboxes are unchecked. The **Apply** button is visible.

Area ID: ◀ CB-9 ▶

☐ Window Center ☐ Highlight

Apply

Details

Options  
Definition  
Subareas  
Computation

Hydro. Method  
☒ Rational  
☐ SCS

To Node ID: CB-9

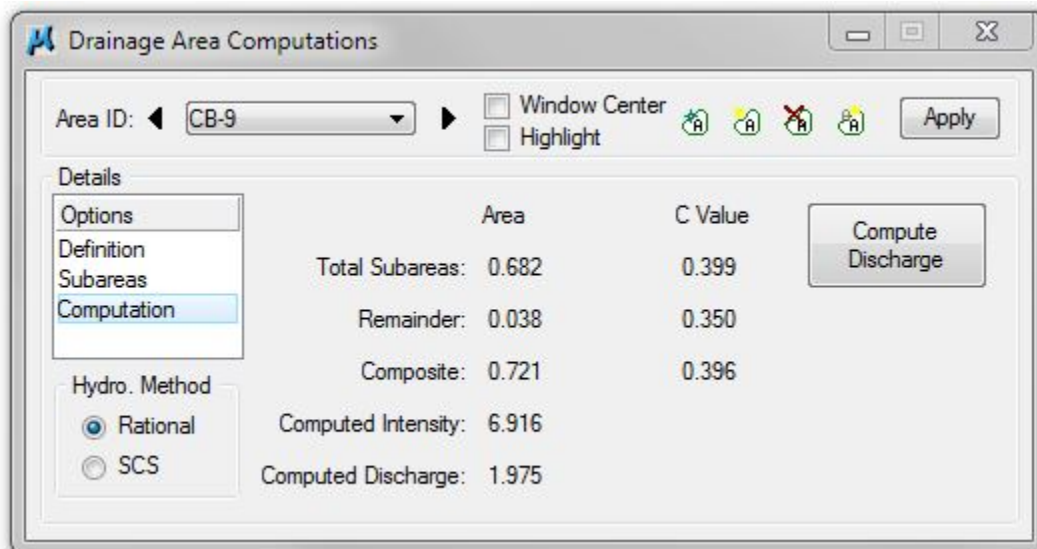
Subarea	C Value	Description
0.1125	0.900	Conc./Asphalt Pvmnt
0.5699	0.300	Forested Areas

Automatic Delineation

☒ Display Only

0.570 0.300 Forested Areas

Compute Discharge and Apply:



The **Drainage Area Computations** dialog box is shown. The **Area ID** is set to **CB-9**. The **Details** tab is selected, showing a table of computations. The **Hydro. Method** is set to **Rational**. The **Window Center** and **Highlight** checkboxes are unchecked. The **Compute Discharge** button is visible.

Area ID: ◀ CB-9 ▶

☐ Window Center ☐ Highlight

Apply

Details

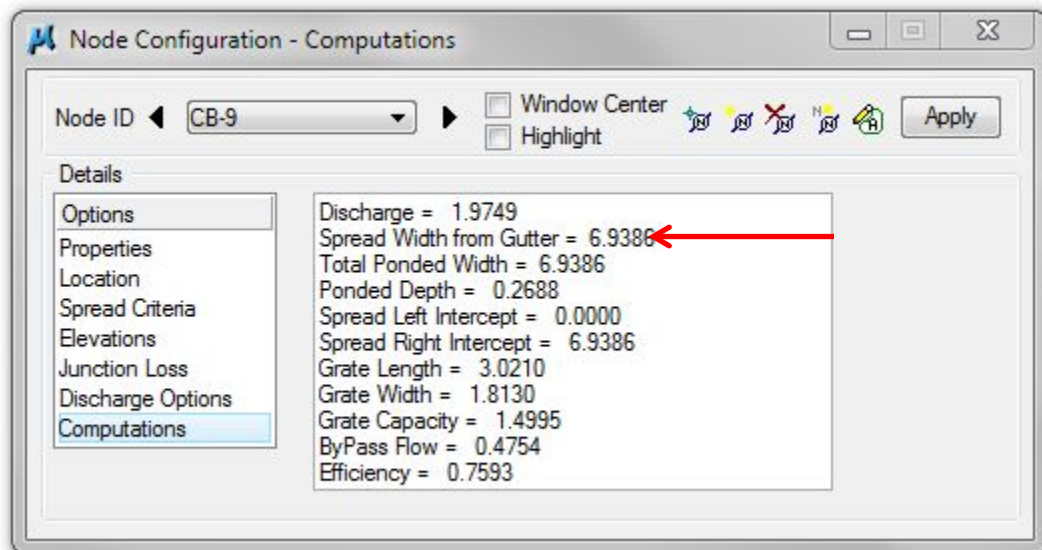
Options  
Definition  
Subareas  
Computation

Hydro. Method  
☒ Rational  
☐ SCS

	Area	C Value
Total Subareas:	0.682	0.399
Remainder:	0.038	0.350
Composite:	0.721	0.396
Computed Intensity:	6.916	
Computed Discharge:	1.975	

Compute Discharge

**Step 3.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



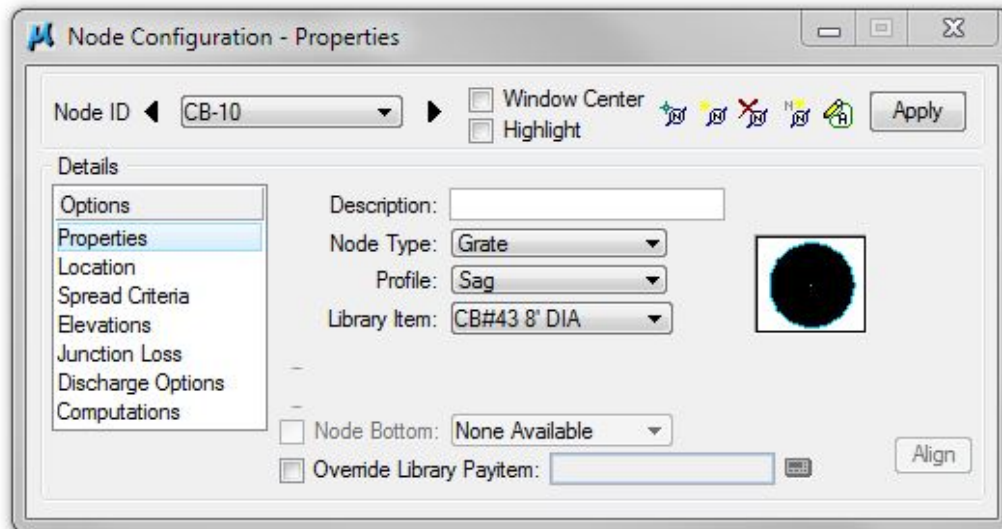
Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

## 5.18 Design Inlet CB – 10

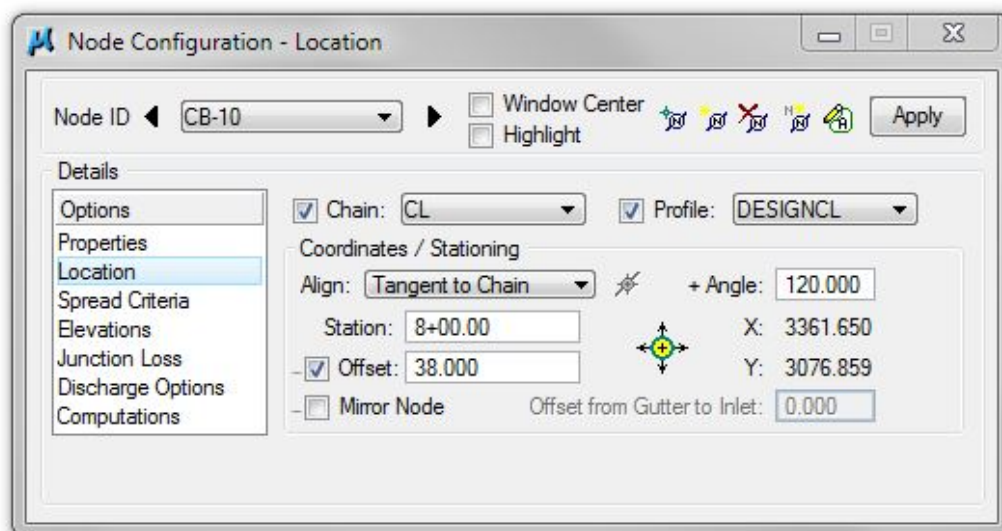
- Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog. Click **OK** to set the name CB-10

**Properties >** Change the Node **Properties** to **Sag** and to a **CB#43 8' DIA**:



**NOTE:** 8' Diameter is a round catch basin. The reasoning behind this selection is the need for the grates to be at such an angle that a pipe cannot be attached at a skew within the required limits. See TDOT Drainage Manual Chapter 7 Section 7.03.5.5 Pipe Connections to Structures.

- Step 2. Location >** All Reference information is defaulted from the previous Node (CB-9) such that only the **+ Angle**, **Station** and the **Offset** needs to be changed. The reasoning for the location of CB-10 will be given in the drainage area discussion. Especially note the Angle and Offset:



**Step 3. Spread Criteria** > Enter the Spread Criteria as shown below.

**% Slope Left:** 5.00 % (From DTM Tools>Analysis>Height/Slope)

**% Slope Right:** 5.00 % (From DTM Tools>Analysis>Height/Slope)

**% Discharge Left:** 50.00% (Estimated based on placement within drainage area)

**% Discharge Right:** 50.00% (Leftover area)

**NOTE:** Left and Right are set equal since the flow will come to each equally.

Node ID:

Details

Options  
Properties  
Location  
Spread Criteria  
Elevations  
Junction Loss  
Discharge Options  
Computations

% Slope Left:  Right:   
% Discharge Left:  Right:   
Spread Cross Section:  
Spread Source:   
Maximum  
Pond Depth:   
Pond Width:   

Width	% Slope	Roughness
4.095	-1.925	0.016
1.906	-50.003	0.016
1.000	-2.000	0.016

**Step 4. Elevations** > Elevation Data must be changed to match a CB#43 8' DIA. From the [TDOT GEOPAK Drainage Nodes](#) Document set the following:

Node ID:

Details

Options  
Properties  
Location  
Spread Criteria  
Elevations  
Junction Loss  
Discharge Options  
Computations

Reference Surface:     
Elevation Source:    
Node Elevation Option:    
Vertical Alignment:    
Minimum Depth:   
Maximum Depth:   
☐ Add Sump Depth:

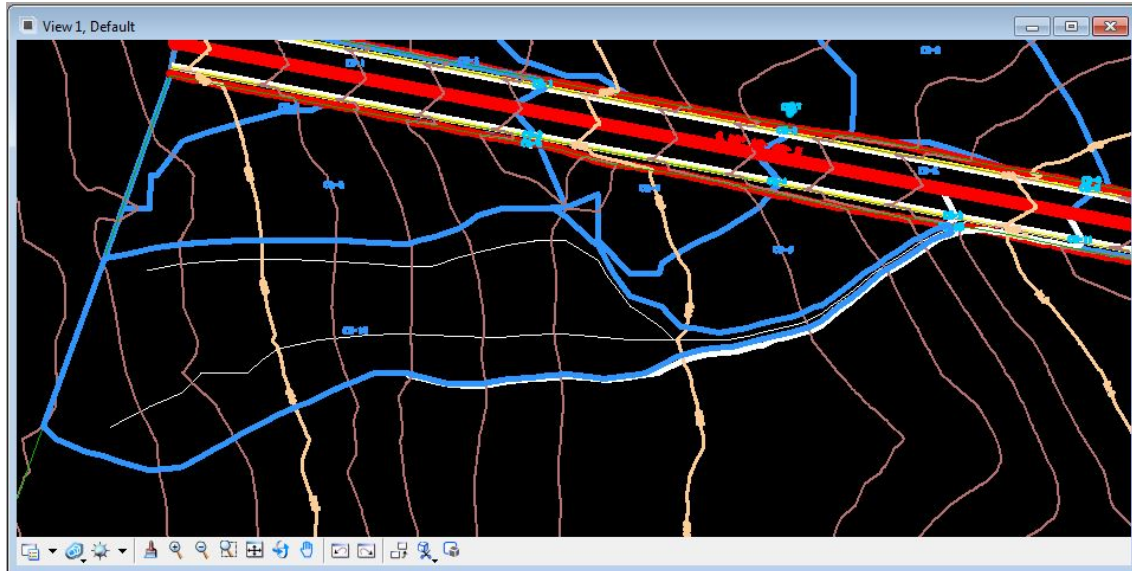
**Step 5.** Click the **Apply** button to include this node in the Drainage Project.



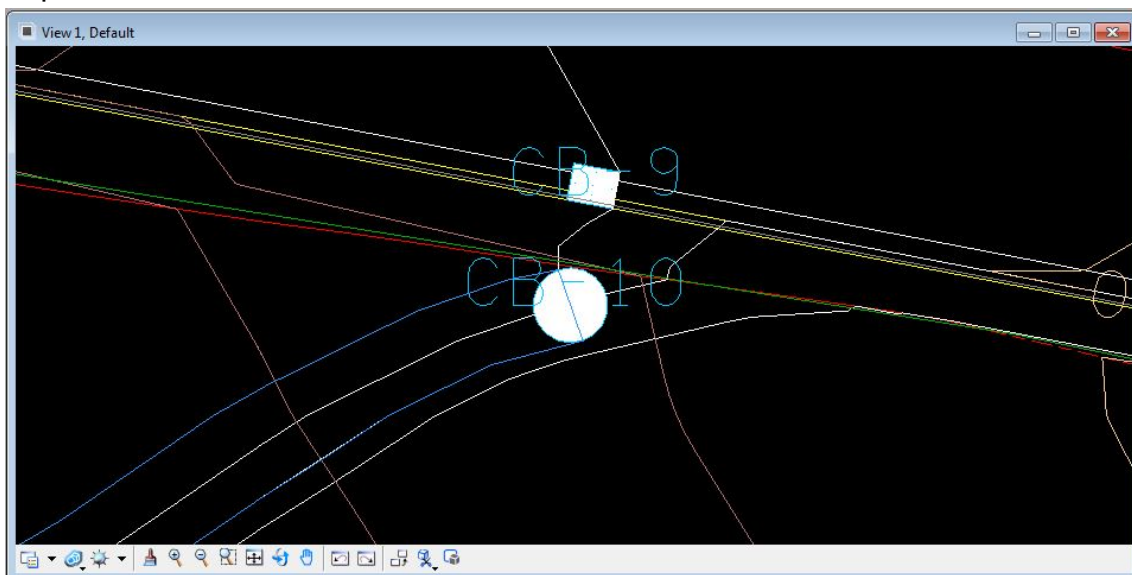
## 5.19 Create Drainage Area CB – 10

- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-10** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 10. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

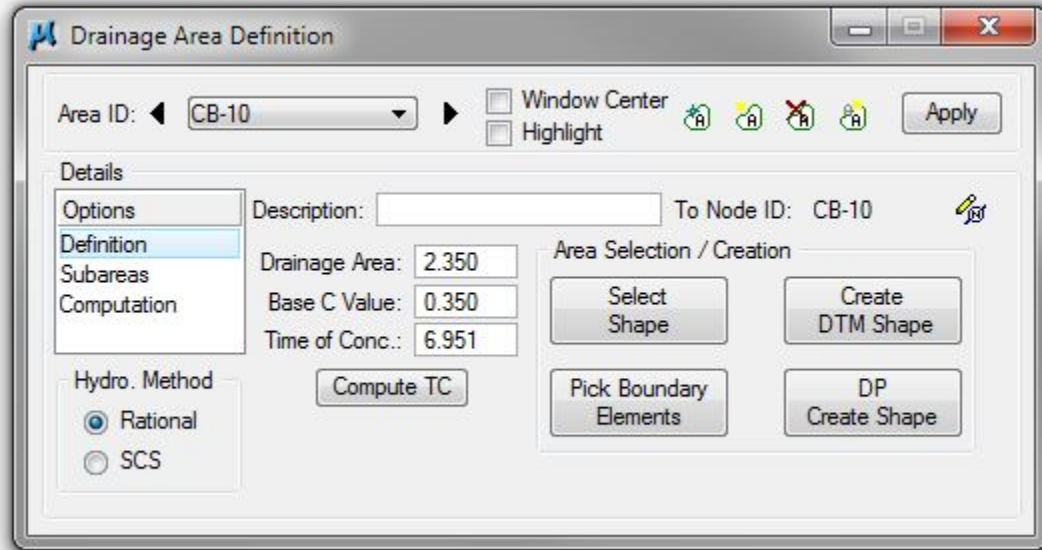
Delineate Drainage Area:



**NOTE:** Drainage area CB-10 was created by first using downstream trace and discovering that it converges into a relatively small area. Therefore when CB-10 was placed, upstream trace was used from either side of the catch basin to determine the drainage area. CB-10 was rotated to match the contours in order to catch as much flow as possible.

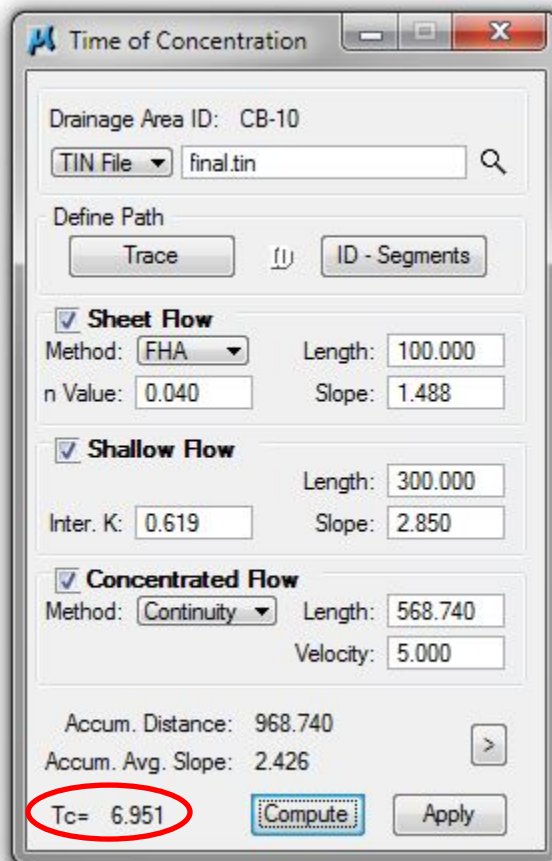


Define Drainage Area:



The "Drainage Area Definition" dialog box is shown. It features a "Details" section on the left with tabs for "Options", "Definition", "Subareas", and "Computation". The "Definition" tab is active, showing fields for "Drainage Area" (2.350), "Base C Value" (0.350), and "Time of Conc." (6.951). There are also checkboxes for "Window Center" and "Highlight", and an "Apply" button. The "Area Selection / Creation" section on the right includes buttons for "Select Shape", "Create DTM Shape", "Pick Boundary Elements", and "DP Create Shape".

Calculate Time of Concentration:



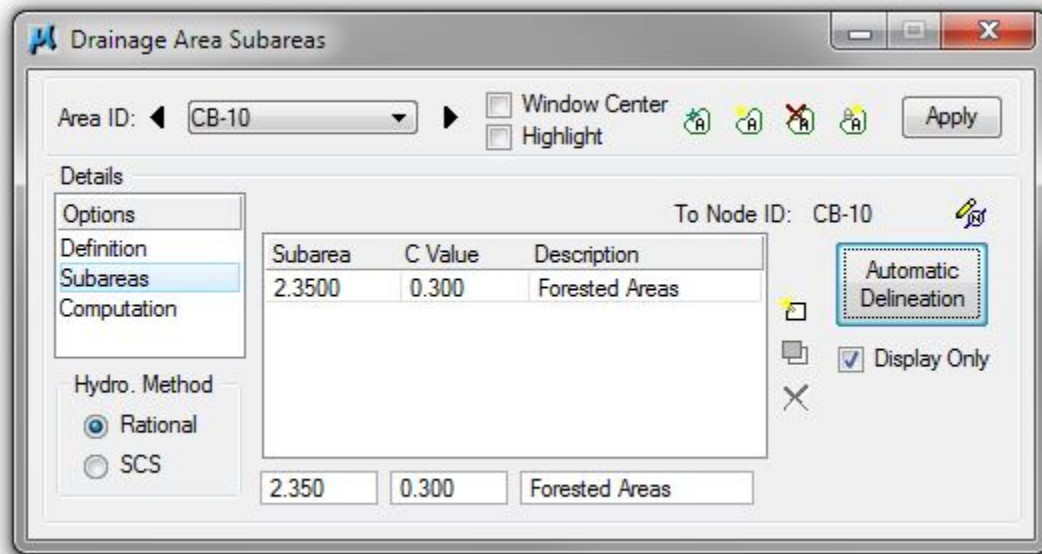
The "Time of Concentration" dialog box is shown. It displays the "Drainage Area ID" as "CB-10" and the "TIN File" as "final.tin". The "Define Path" section has buttons for "Trace" and "ID - Segments". The "Sheet Flow" section is checked, with "Method" set to "FHA", "Length" at 100.000, and "n Value" at 0.040. The "Shallow Flow" section is also checked, with "Length" at 300.000 and "Inter. K" at 0.619. The "Concentrated Flow" section is checked, with "Method" set to "Continuity", "Length" at 568.740, and "Velocity" at 5.000. The "Accum. Distance" is 968.740 and the "Accum. Avg. Slope" is 2.426. The "Tc" value is 6.951, which is circled in red. There are "Compute" and "Apply" buttons.

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required.














**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area.

## Exercise 5

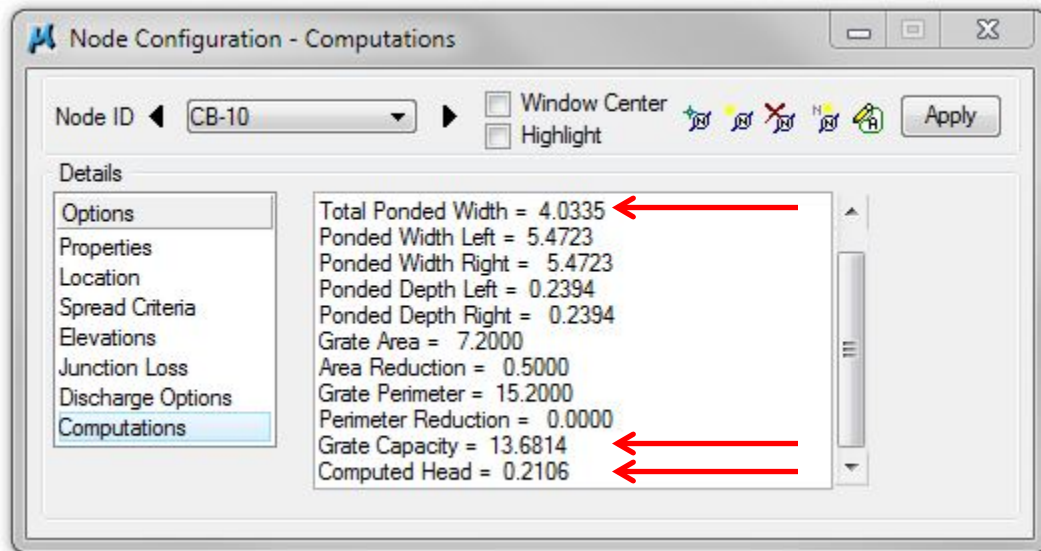
Delineate Subareas utilizing the Land Use DGN:



The **Drainage Area Subareas** dialog box is shown. The **Area ID** is set to **CB-10**. The **Details** tab is selected, showing a table of subareas. The **Hydro. Method** is set to **Rational**. The **Automatic Delineation** button is highlighted.

Area ID: ◀ CB-10 ▶ ☐ Window Center ☐ Highlight               <

**Step 3.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

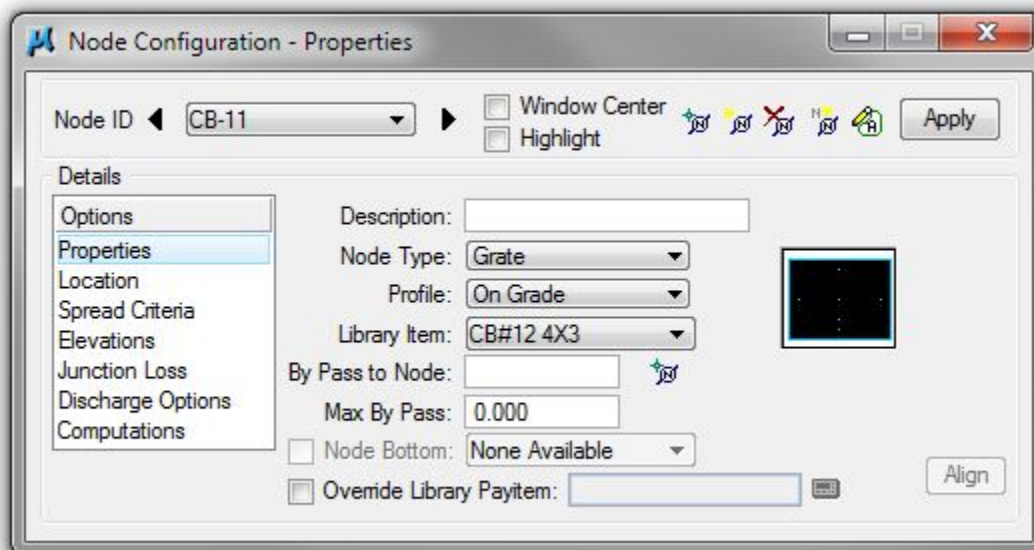
**NOTE:** Review the Computed Data. Items to review specifically are:

**Total Pondered Width, Grate Capacity** compared with **Computed Discharge** and **Computed Head**

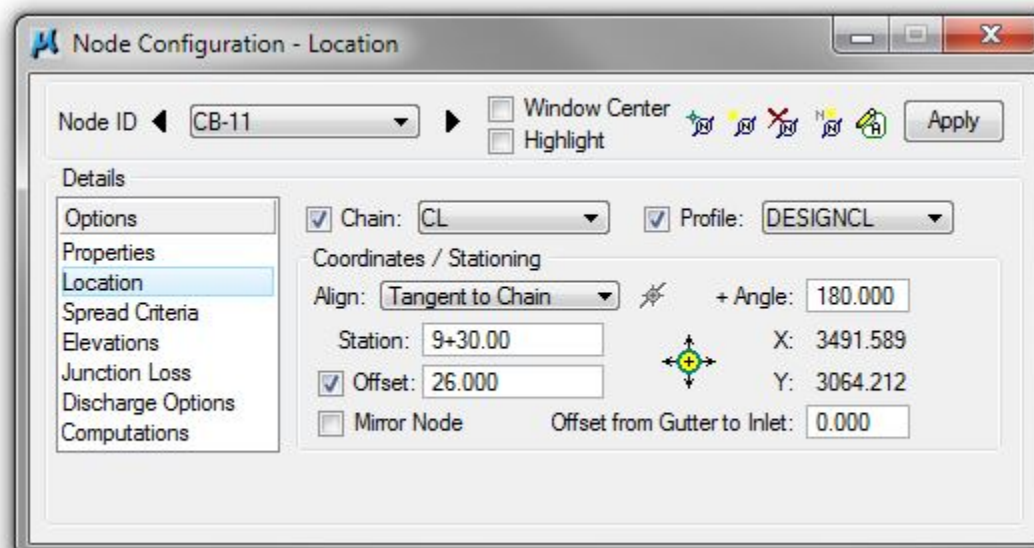
## 5.20 Design Inlet CB – 11

**Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog. Click **OK** to set the name CB-11

**Properties >** Change the Node **Properties** to **On Grade** and to a **CB#12 4x3**:



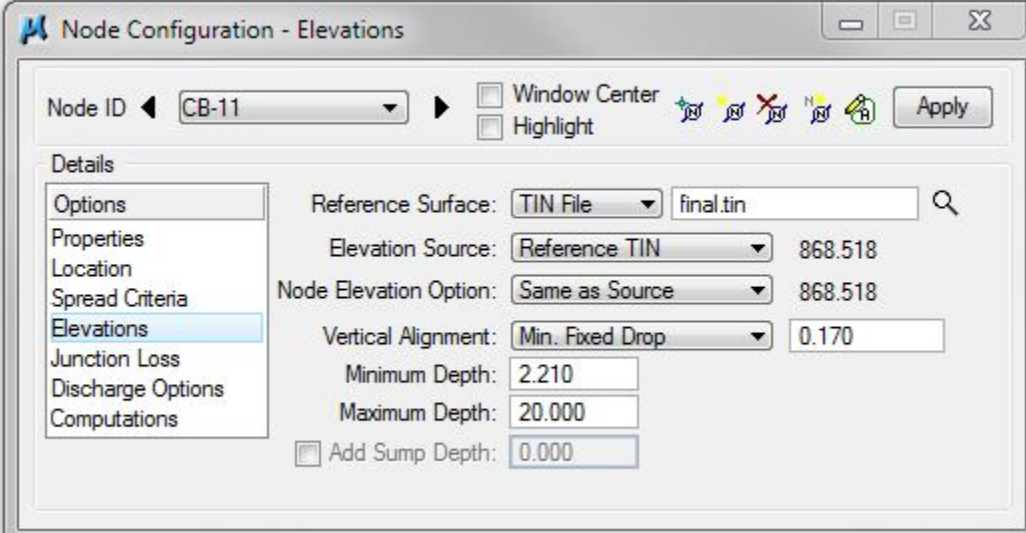
**Step 2.** **Location >** All Reference information is defaulted from the previous Node (CB-10) such that only the **+ Angle**, **Station** and the **Offset** needs to be changed:



**NOTE:** The **Spread Criteria** defaults back automatically when the node is changed back to **ON GRADE**, therefore no changes are necessary.



**Step 3. Elevations** > Elevation Data must be changed to match a CB#12 4X3. From the [TDOT GEOPAK Drainage Nodes](#) Document set the following:



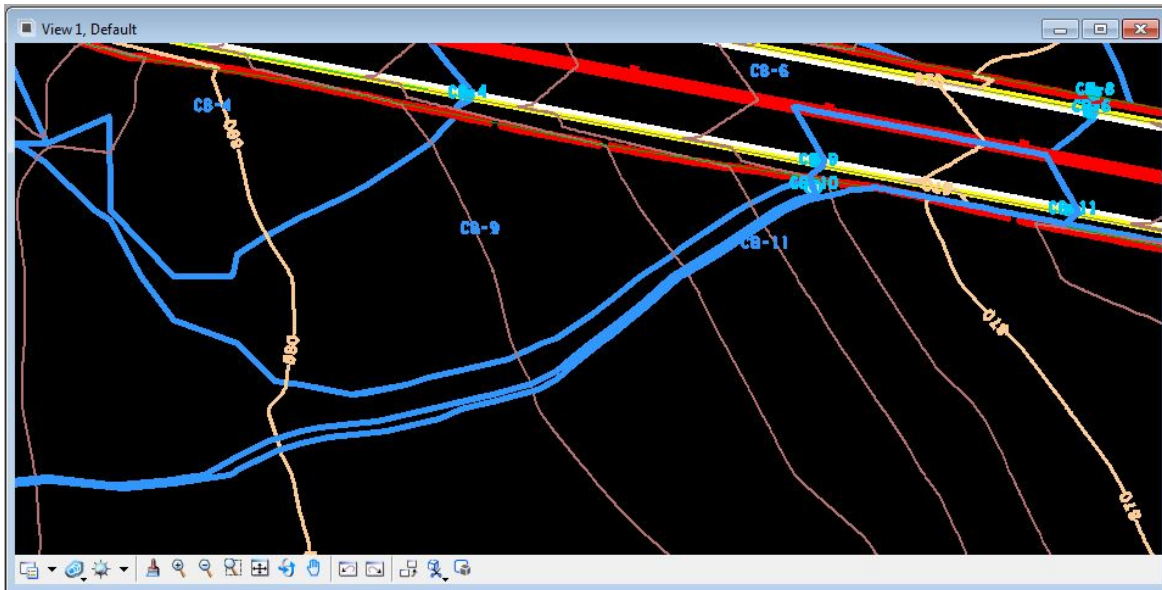
The image shows a software dialog box titled "Node Configuration - Elevations". At the top, there is a "Node ID" dropdown menu set to "CB-11". To its right are checkboxes for "Window Center" and "Highlight", followed by several small icons and an "Apply" button. Below this is a "Details" section with a vertical list of options on the left: "Options", "Properties", "Location", "Spread Criteria", "Elevations" (which is highlighted in blue), "Junction Loss", "Discharge Options", and "Computations". To the right of this list are configuration fields: "Reference Surface" is a dropdown set to "TIN File" with a text box containing "final.tin"; "Elevation Source" is a dropdown set to "Reference TIN" with a value of "868.518"; "Node Elevation Option" is a dropdown set to "Same as Source" with a value of "868.518"; "Vertical Alignment" is a dropdown set to "Min. Fixed Drop" with a value of "0.170"; "Minimum Depth" is a text box with "2.210"; "Maximum Depth" is a text box with "20.000"; and "Add Sump Depth" is a checkbox followed by a text box with "0.000".

**Step 4.** Click the **Apply** button to include this node in the Drainage Project.

## 5.21 Create Drainage Area CB – 11

- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-11** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 11. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

Delineate Drainage Area:



**NOTE:** There is a small sliver of CB-11 Drainage Area that lies alongside CB-10. This is included to make sure all drainage area is captured. In reality, this sliver would likely be captured by CB-10

Define Drainage Area:

Calculate Time of Concentration:

Drainage Area ID: CB-11

TIN File: final.tin

Define Path: Trace, ID - Segments

☒ **Sheet Flow**  
 Method: FHA Length: 26.000  
 n Value: 0.040 Slope: 2.631

☒ **Shallow Flow**  
 Length: 128.062  
 Inter. K: 0.619 Slope: 1.852

☒ **Concentrated Flow**  
 Method: Continuity Length: 0.000  
 Velocity: 5.000

Accum. Distance: 154.062  
 Accum. Avg. Slope: 1.983

**Tc= 2.080** Compute Apply

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore **5 must be manually typed** in the Drainage Area Definition dialog after hitting apply in the Time of Concentration Window.

**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area.

Delineate Subareas utilizing the Land Use DGN:

Area ID: CB-11

☐ Window Center ☐ Highlight

Details

Options

Definition

**Subareas**

Computation

Hydro. Method

☒ Rational

☐ SCS

To Node ID: CB-11

Subarea	C Value	Description
0.0793	0.900	Conc/Asphalt Pvmnt
0.0442	0.300	Forested Areas

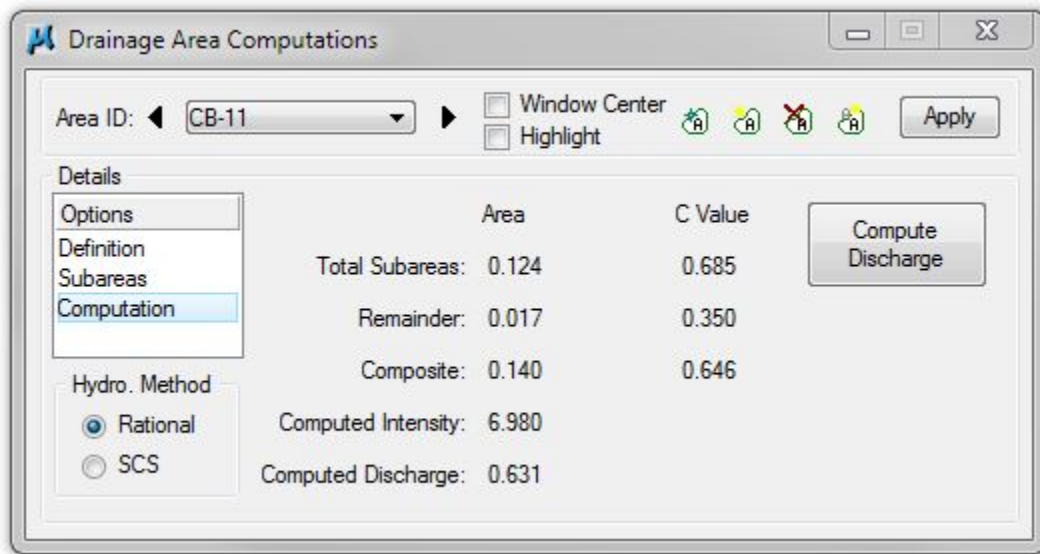
**Automatic Delineation**

☒ Display Only

0.044 0.300 Forested Areas

## Exercise 5

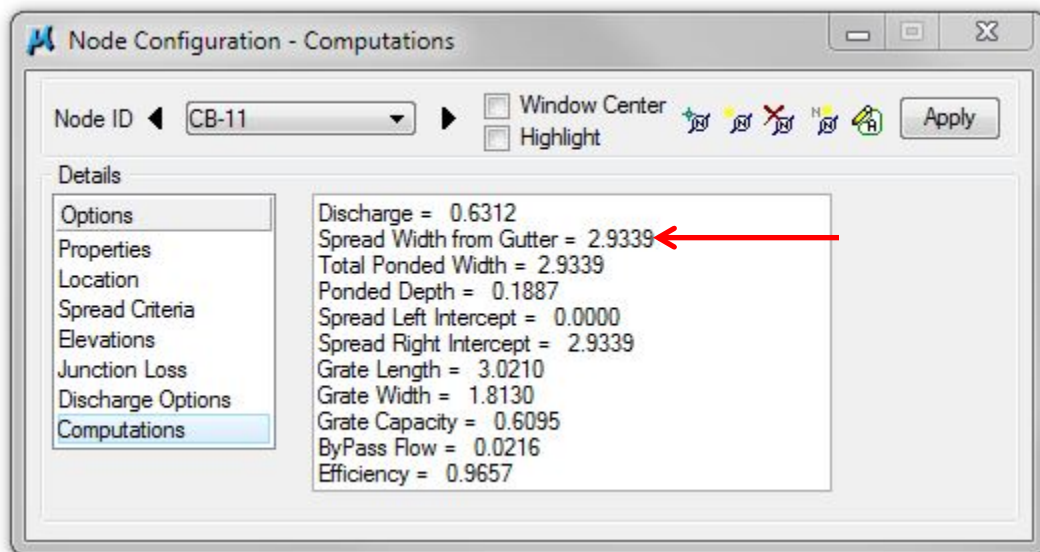
Compute Discharge and Apply:



The 'Drainage Area Computations' dialog box shows the 'Area ID' as 'CB-11'. The 'Details' section on the left has 'Computation' selected. The 'Hydro. Method' section has 'Rational' selected. The 'Compute Discharge' button is visible. The main area displays the following data:

	Area	C Value
Total Subareas:	0.124	0.685
Remainder:	0.017	0.350
Composite:	0.140	0.646
Computed Intensity:	6.980	
Computed Discharge:	0.631	

**Step 3.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



The 'Node Configuration - Computations' dialog box shows the 'Node ID' as 'CB-11'. The 'Details' section on the left has 'Computations' selected. The main area displays the following data:

Discharge =	0.6312
Spread Width from Gutter =	2.9339
Total Ponded Width =	2.9339
Ponded Depth =	0.1887
Spread Left Intercept =	0.0000
Spread Right Intercept =	2.9339
Grate Length =	3.0210
Grate Width =	1.8130
Grate Capacity =	0.6095
ByPass Flow =	0.0216
Efficiency =	0.9657

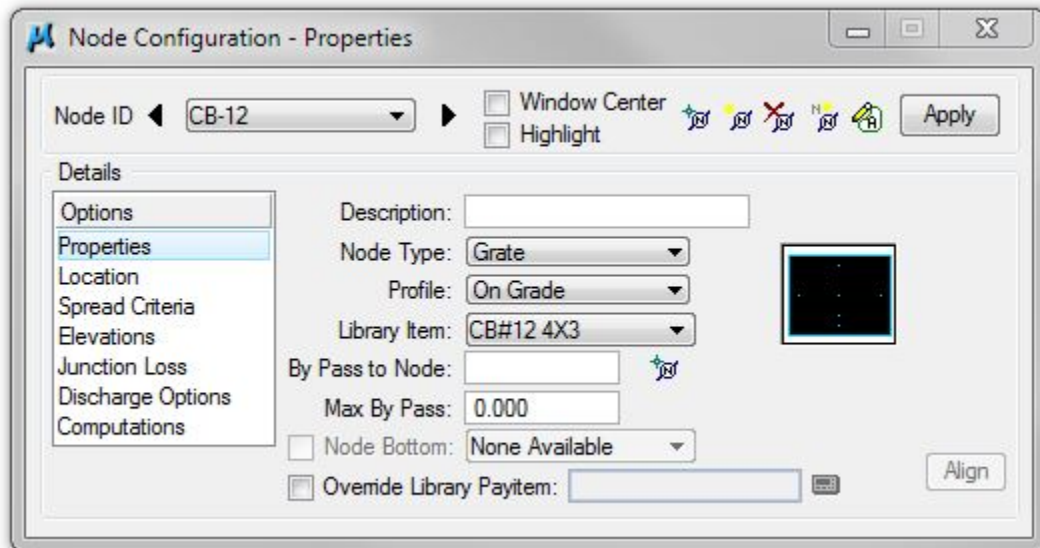
Don't be alarmed if your results are off by a few 100<sup>th</sup>s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

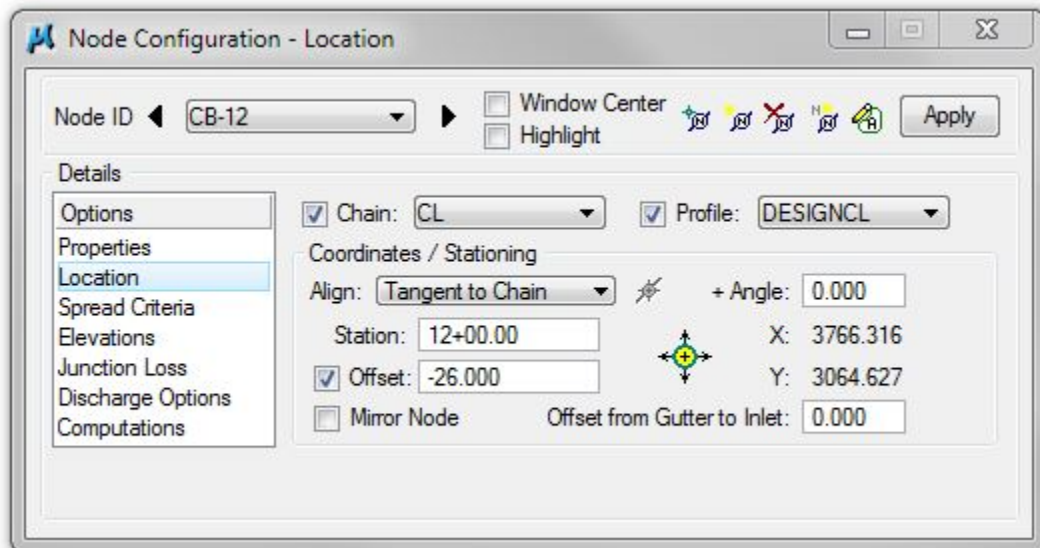
## 5.22 Design Inlet CB – 12

**Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog. Click **OK** to set the name CB-12

**Properties >** Verify the Node Properties are defaulted from the previous Node (CB-11) such that no user-input is required for this similar curb inlet.



**Step 2.** **Location >** All Reference information is defaulted from the previous Node (CB-11) such that only the **+ Angle**, **Station** and the **Offset** needs to be changed:



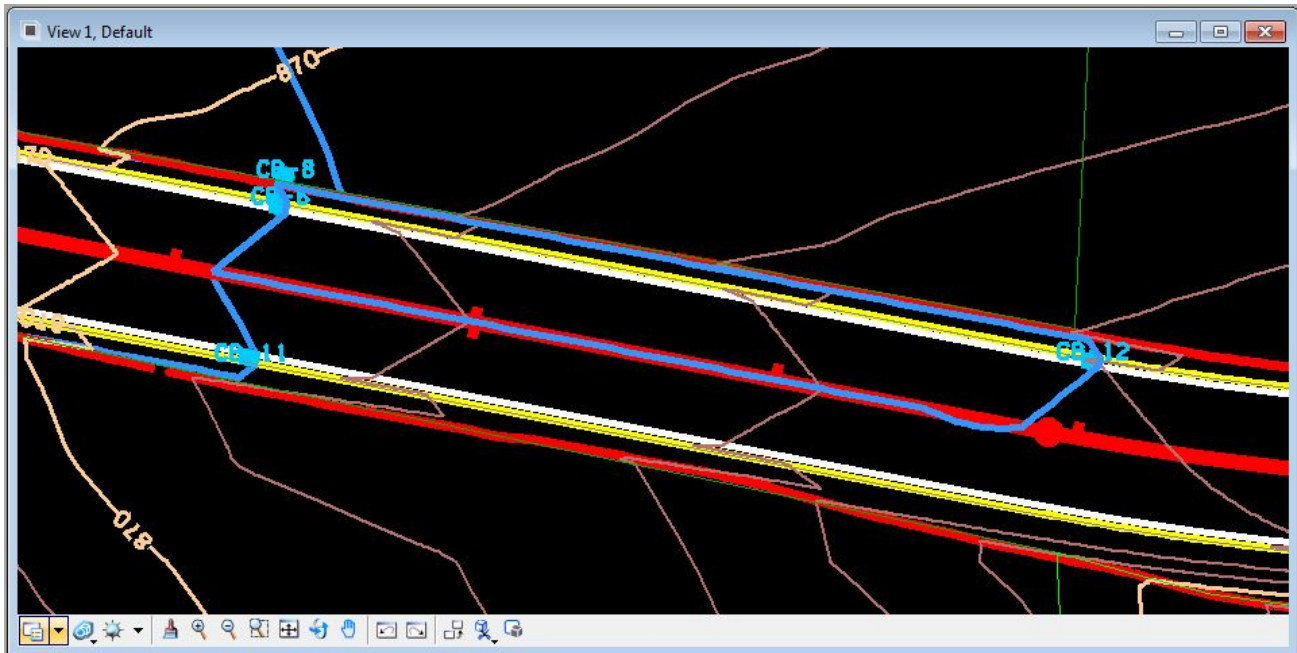
**Step 3.** Click the **Apply** button to include this node in the Drainage Project.



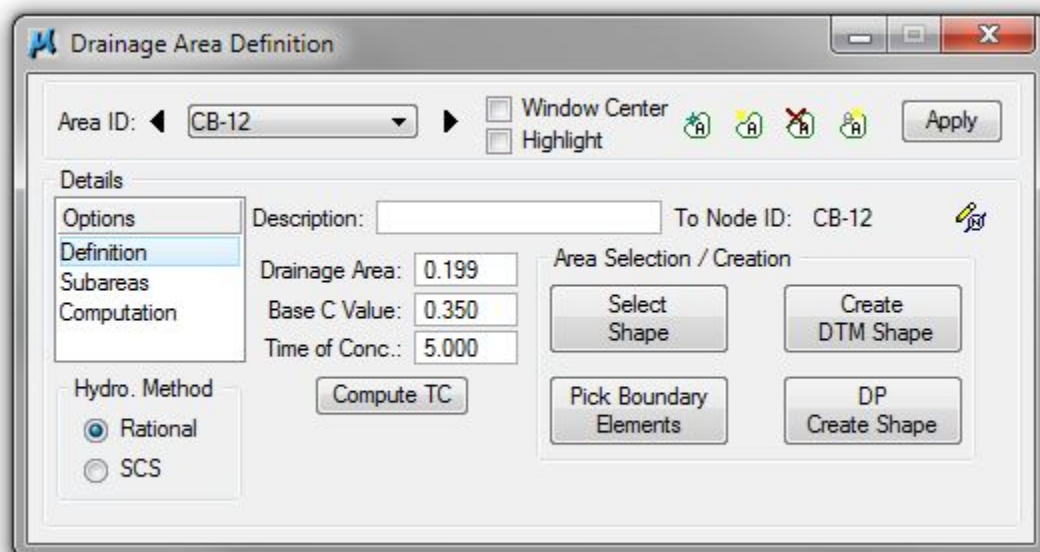
### 5.23 Create Drainage Area CB – 12

- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-12** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 12. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

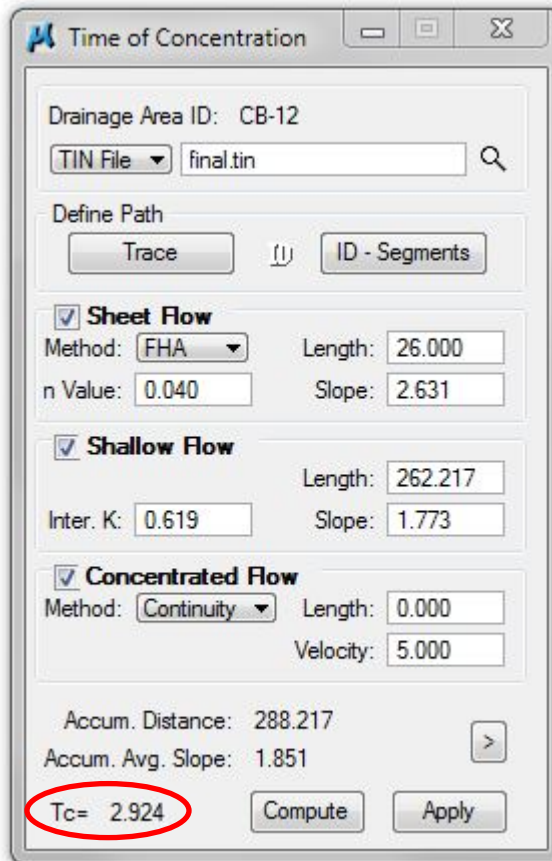
Delineate Drainage Area:



Define Drainage Area:



Calculate Time of Concentration:



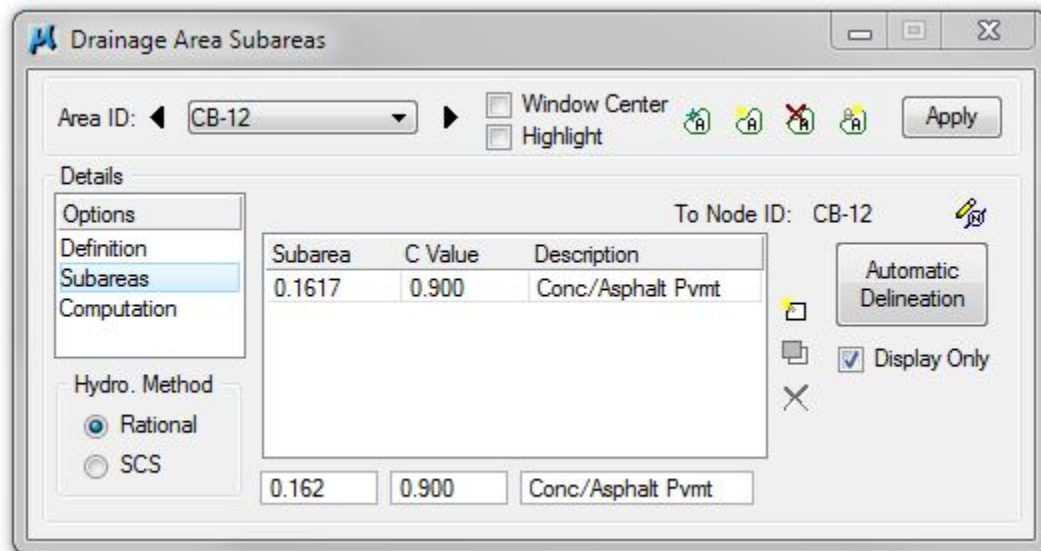
The dialog box 'Time of Concentration' is shown. It contains the following fields and controls:

- Drainage Area ID: CB-12
- TIN File: final.tin
- Define Path: Trace, ID - Segments
- ☒ **Sheet Flow**
  - Method: FHA
  - Length: 26.000
  - n Value: 0.040
  - Slope: 2.631
- ☒ **Shallow Flow**
  - Length: 262.217
  - Inter. K: 0.619
  - Slope: 1.773
- ☒ **Concentrated Flow**
  - Method: Continuity
  - Length: 0.000
  - Velocity: 5.000
- Accum. Distance: 288.217
- Accum. Avg. Slope: 1.851
- Tc= 2.924** (circled in red)
- Buttons: Compute, Apply

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore **5 must be manually typed** in the Drainage Area Definition dialog after hitting apply in the Time of Concentration Window.

**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area.

Delineate Subareas utilizing the Land Use DGN:



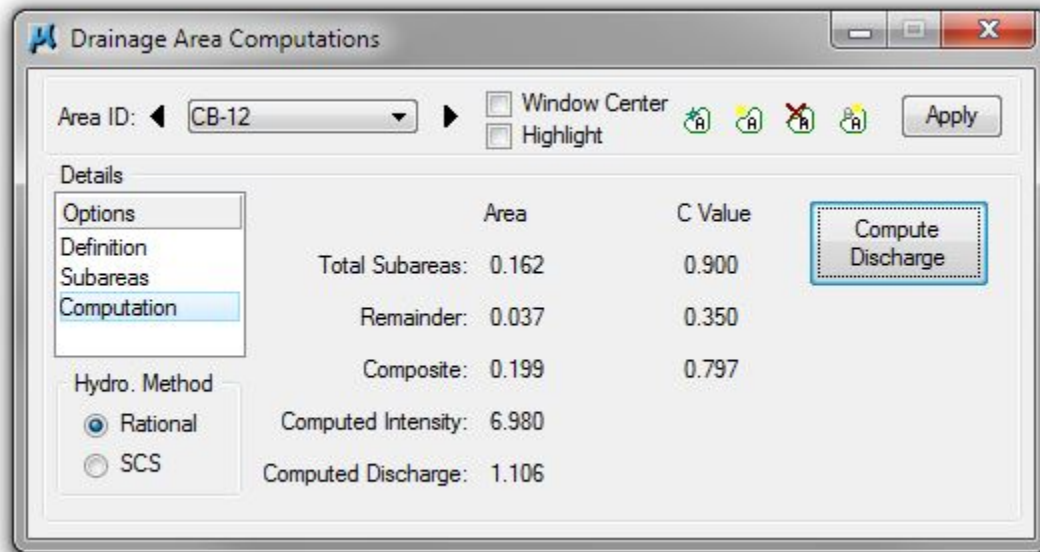
The dialog box 'Drainage Area Subareas' is shown. It contains the following fields and controls:

- Area ID: CB-12
- Window Center: ☐
- Highlight: ☐
- Buttons: Apply
- Details:
  - Options
  - Definition
  - Subareas**
  - Computation
- Hydro. Method:
  - ☒ Rational
  - ☐ SCS
- To Node ID: CB-12
- Automatic Delineation: ☐
- Display Only: ☒
- Table:
 

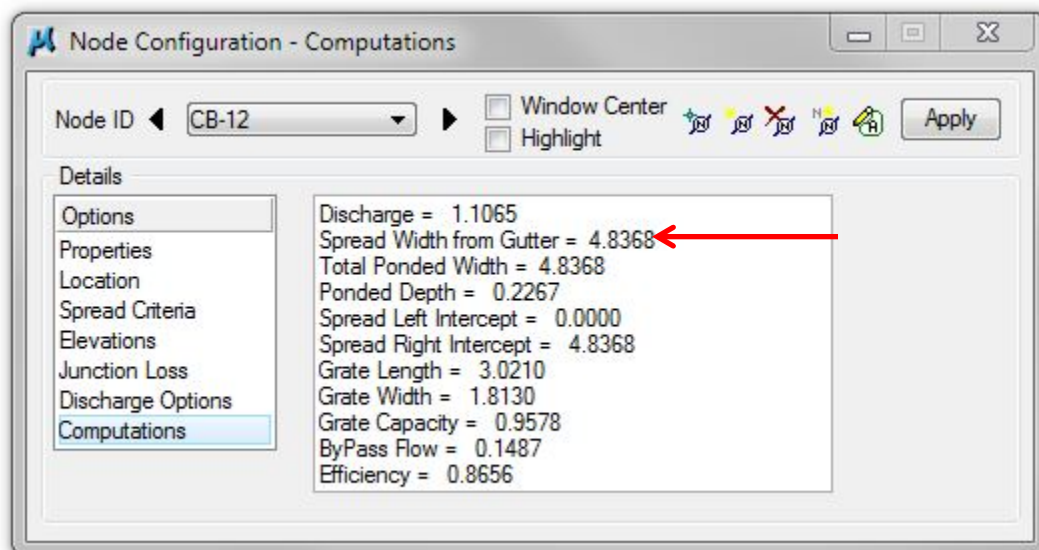
Subarea	C Value	Description
0.1617	0.900	Conc/Asphalt Pvmnt
- Bottom fields: 0.162, 0.900, Conc/Asphalt Pvmnt

## Exercise 5

Compute Discharge and Apply:



**Step 3.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



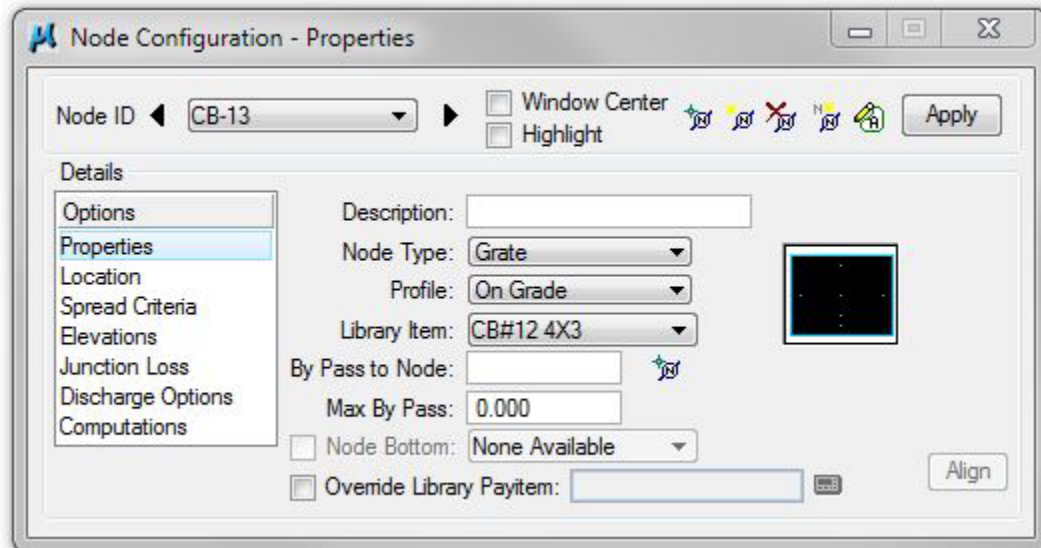
Don't be alarmed if your results are off by a few 100<sup>th</sup>s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

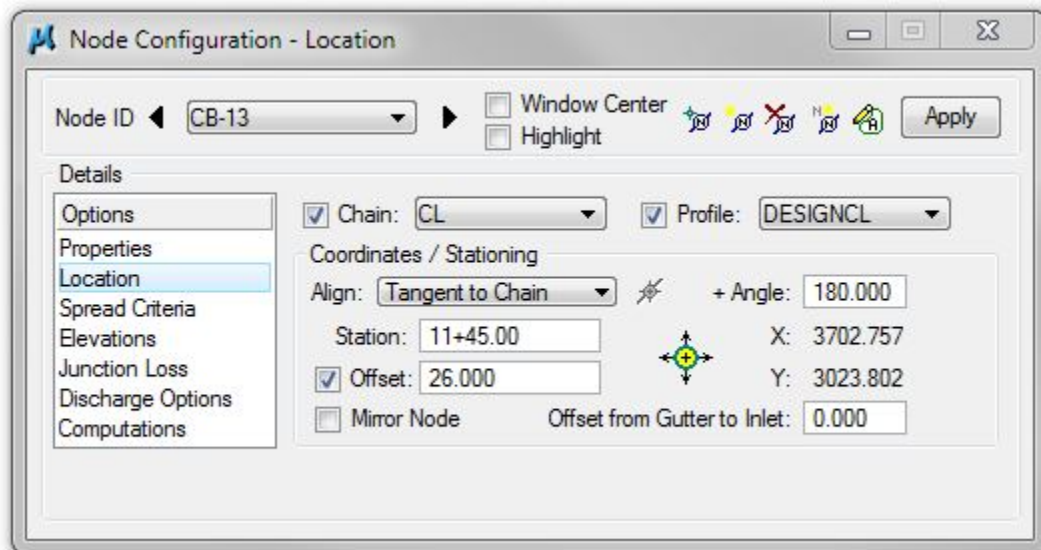
## 5.24 Design Inlet CB – 13

- Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog. Click **OK** to set the name CB-13

**Properties >** Verify the Node Properties are defaulted from the previous Node (CB-12) such that no user-input is required for this similar curb inlet.



- Step 2. Location >** All Reference information is defaulted from the previous Node (CB-12) such that only the **+ Angle**, **Station** and the **Offset** needs to be changed. This station is not set equal to CB-12 due to changing super elevation shapes. After a few iterations this station was chosen in order to keep the spread within the limits. :



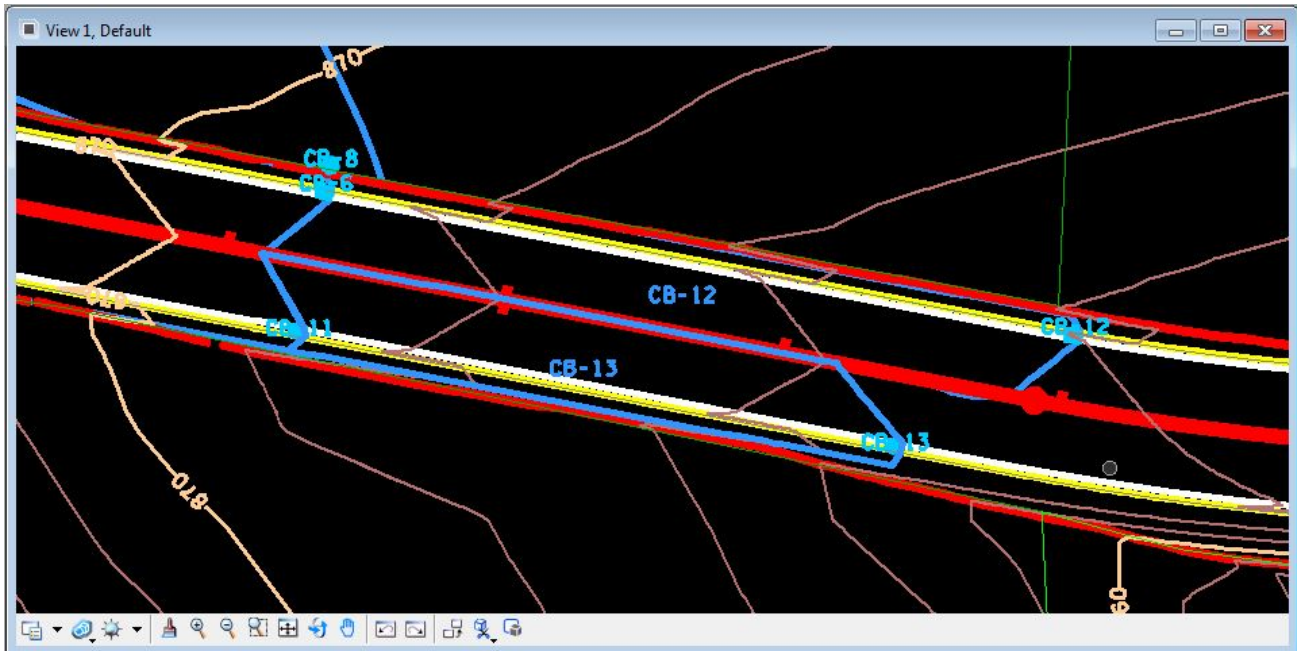
- Step 3.** Click the **Apply** button to include this node in the Drainage Project.



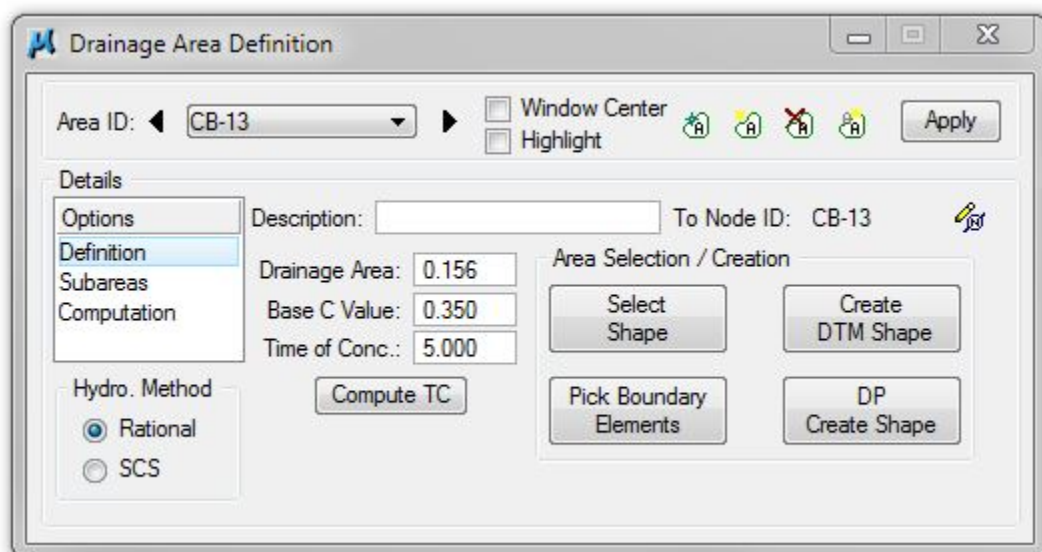
## 5.25 Create Drainage Area CB – 13

- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-13** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 13. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

Delineate Drainage Area:

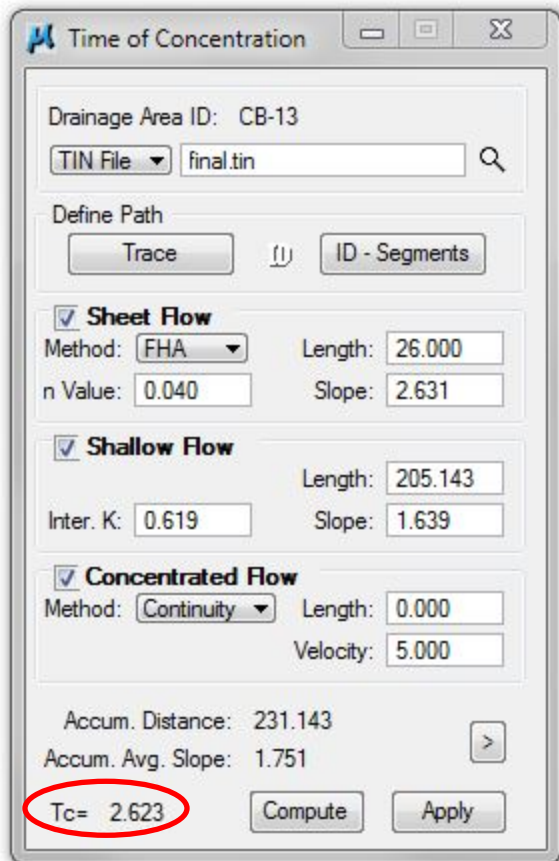


Define Drainage Area:





Calculate Time of Concentration:



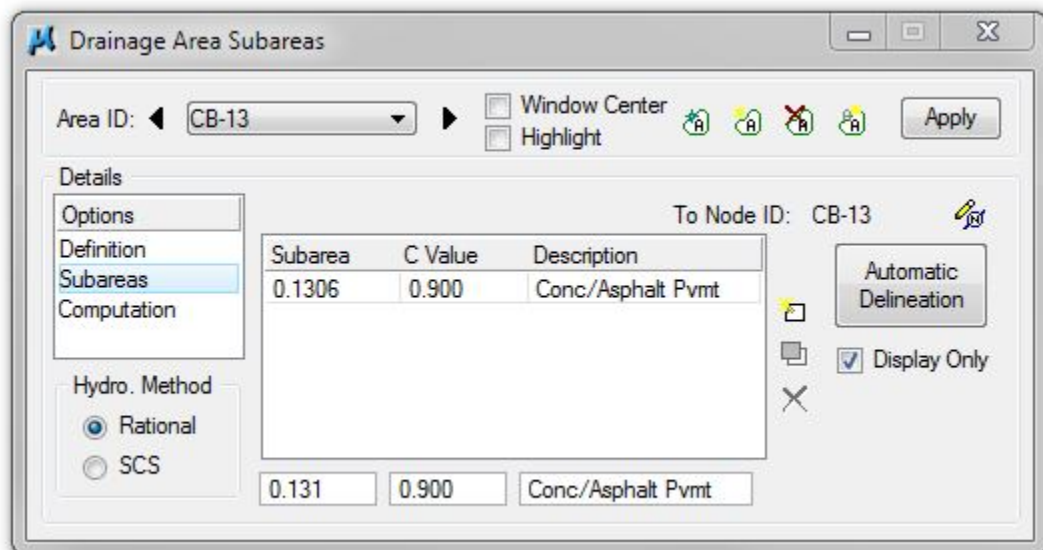
The dialog box is titled "Time of Concentration". It contains the following fields and controls:

- Drainage Area ID: CB-13
- TIN File: final.tin
- Define Path: Trace (disabled), ID - Segments (active)
- ☒ **Sheet Flow**
  - Method: FHA
  - Length: 26.000
  - n Value: 0.040
  - Slope: 2.631
- ☒ **Shallow Flow**
  - Length: 205.143
  - Inter. K: 0.619
  - Slope: 1.639
- ☒ **Concentrated Flow**
  - Method: Continuity
  - Length: 0.000
  - Velocity: 5.000
- Accum. Distance: 231.143
- Accum. Avg. Slope: 1.751
- Tc= 2.623** (circled in red)
- Buttons: Compute, Apply

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore **5 must be manually typed** in the Drainage Area Definition dialog after hitting apply in the Time of Concentration Window.

**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area.

Delineate Subareas utilizing the Land Use DGN:



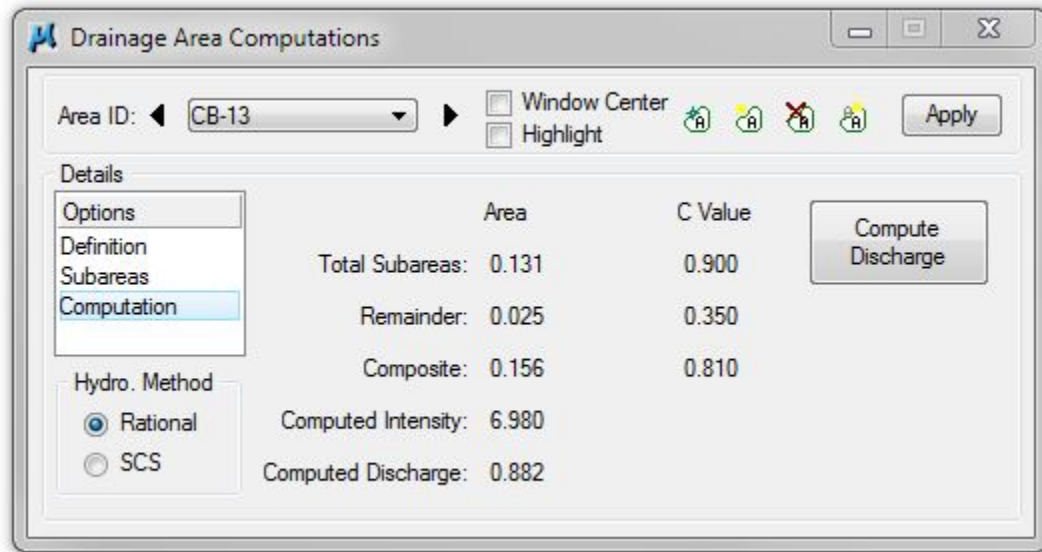
The dialog box is titled "Drainage Area Subareas". It contains the following fields and controls:

- Area ID: CB-13
- Window Center (checkbox)
- Highlight (checkbox)
- Apply button
- Details section:
  - Options (selected)
  - Definition
  - Subareas (selected)
  - Computation
- Hydro. Method:
  - ☒ Rational
  - ☐ SCS
- To Node ID: CB-13
- Table:
 

Subarea	C Value	Description
0.1306	0.900	Conc/Asphalt Pvmnt
- Automatic Delineation button
- Display Only (checkbox, checked)
- Buttons: X, Copy, Paste

## Exercise 5

Compute Discharge and Apply:

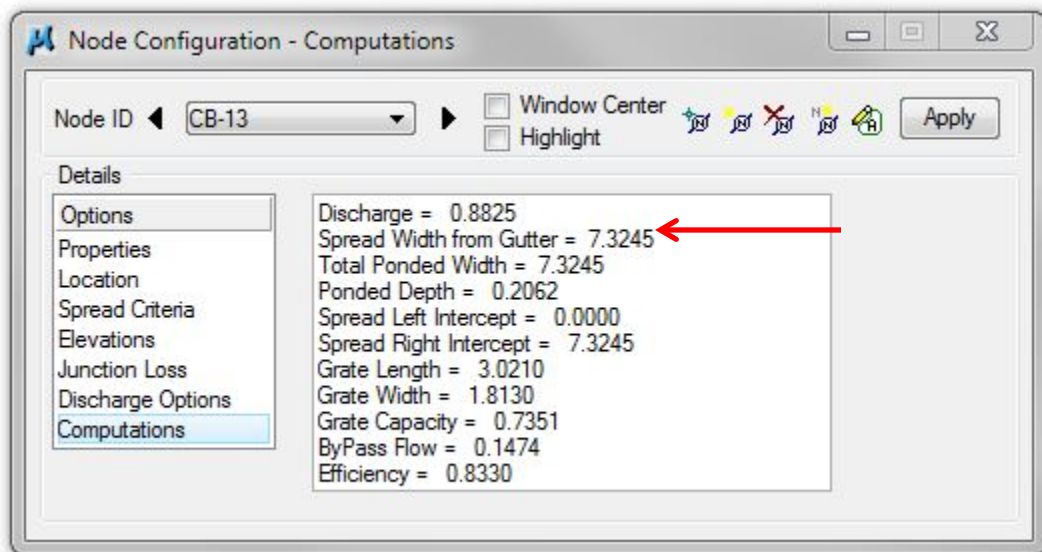


The **Drainage Area Computations** dialog box shows the **Area ID** as **CB-13**. The **Details** section on the left has **Options**, **Definition**, **Subareas**, and **Computation** (selected). The **Hydro. Method** section has **Rational** (selected) and **SCS**. The **Area** and **C Value** columns show the following data:

	Area	C Value
Total Subareas:	0.131	0.900
Remainder:	0.025	0.350
Composite:	0.156	0.810
Computed Intensity:	6.980	
Computed Discharge:	0.882	

Buttons include **Window Center**, **Highlight**, **Apply**, and **Compute Discharge**.

**Step 3.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



The **Node Configuration - Computations** dialog box shows the **Node ID** as **CB-13**. The **Details** section on the left has **Options**, **Properties**, **Location**, **Spread Criteria**, **Elevations**, **Junction Loss**, **Discharge Options**, and **Computations** (selected). The **Computations** section displays the following data:

Discharge =	0.8825
Spread Width from Gutter =	7.3245
Total Ponded Width =	7.3245
Ponded Depth =	0.2062
Spread Left Intercept =	0.0000
Spread Right Intercept =	7.3245
Grate Length =	3.0210
Grate Width =	1.8130
Grate Capacity =	0.7351
ByPass Flow =	0.1474
Efficiency =	0.8330

A red arrow points to the **Spread Width from Gutter = 7.3245** value.

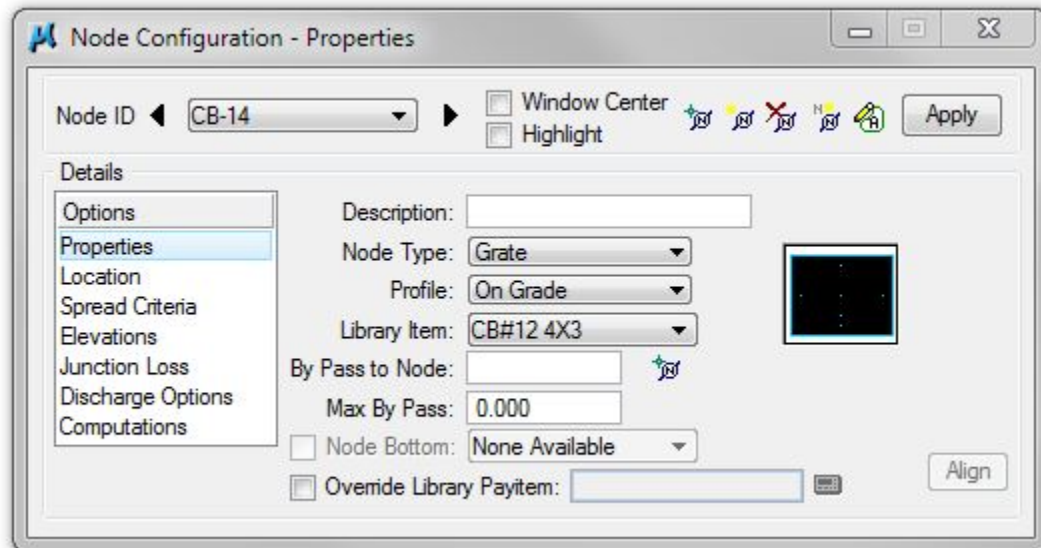
Don't be alarmed if your results are off by a few 100<sup>th</sup>s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

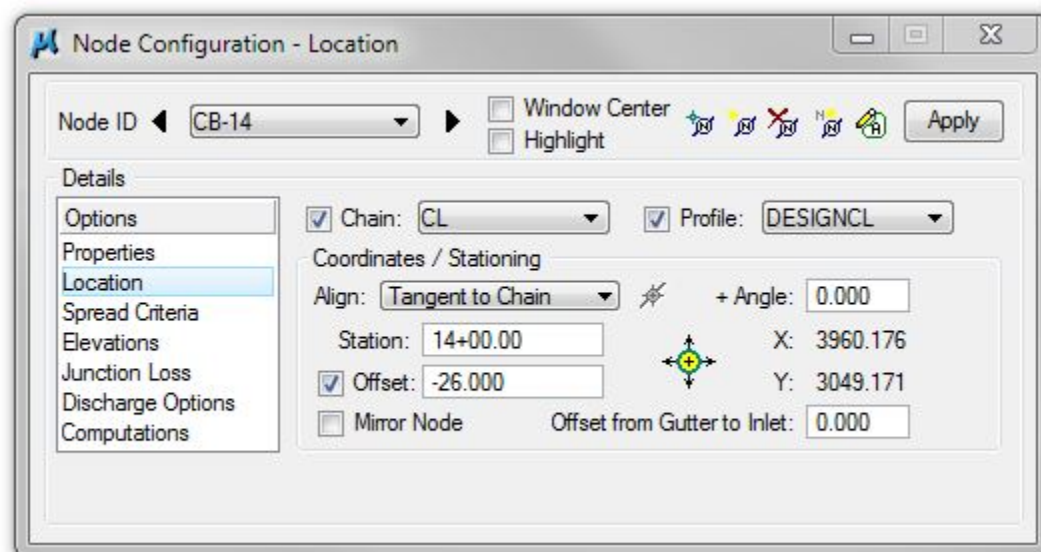
## 5.26 Design Inlet CB – 14

**Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog. Click **OK** to set the name CB-14

**Properties >** Verify the Node Properties are defaulted from the previous Node (CB-13) such that no user-input is required for this similar curb inlet.



**Step 2. Location >** All Reference information is defaulted from the previous Node (CB-13) such that only the **+ Angle**, **Station** and the **Offset** needs to be changed. This station is chosen since it is on an even station and near where we want our outlet:

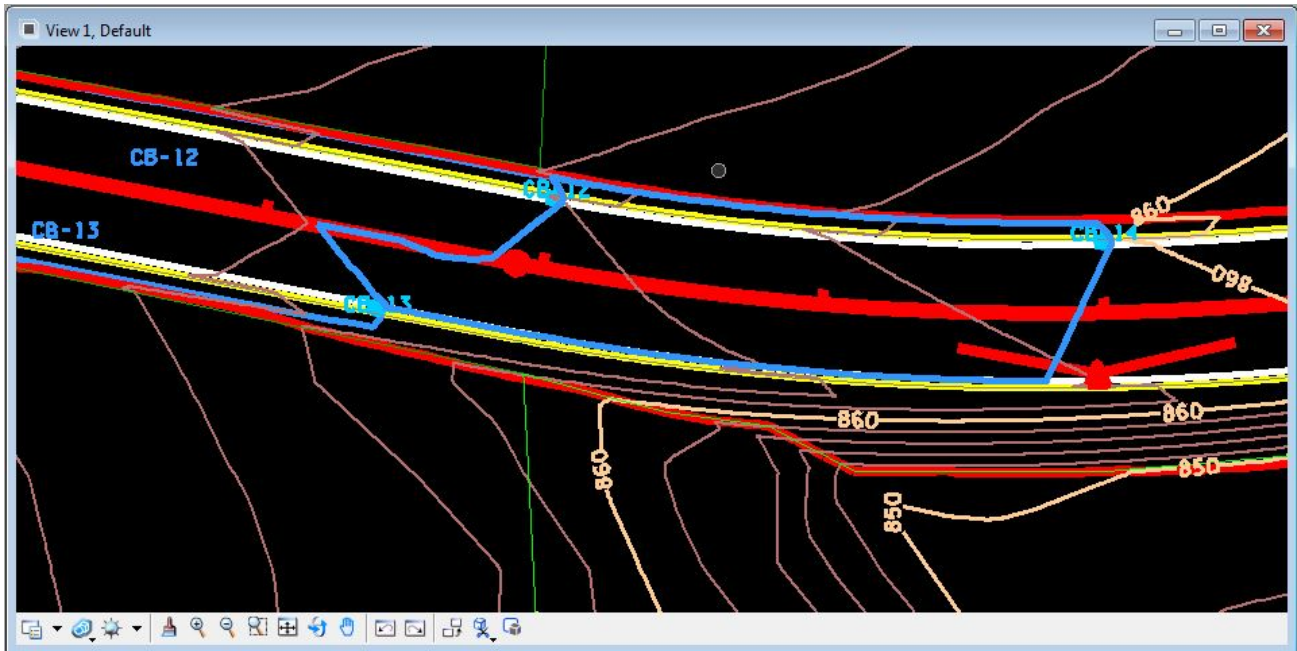


**Step 3.** Click the **Apply** button to include this node in the Drainage Project.

## 5.27 Create Drainage Area CB – 14

- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **CB-14** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for Catch Basin 14. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

Delineate Drainage Area:



Define Drainage Area:

**Drainage Area Definition**

Area ID: **CB-14** ☐ Window Center ☐ Highlight

**Details**

Options  
Definition  
Subareas  
Computation

Description:  To Node ID: **CB-14**

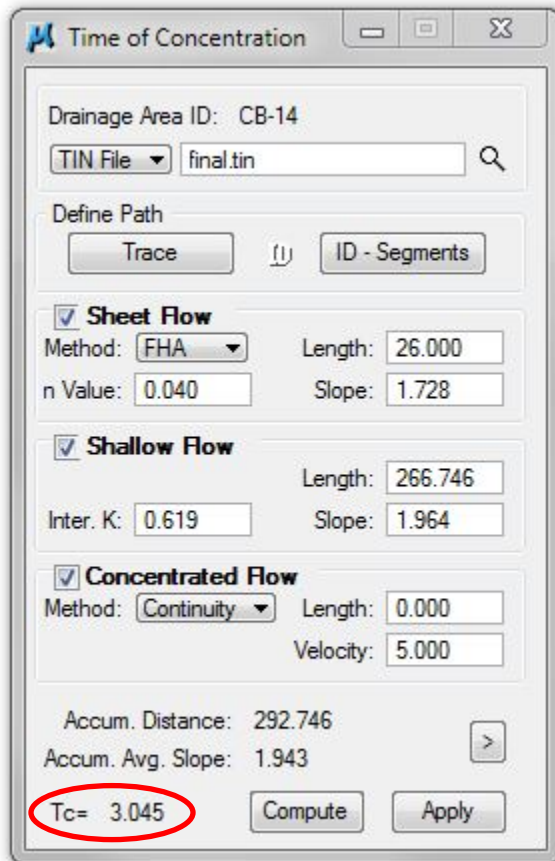
Drainage Area:   
Base C Value:   
Time of Conc.:

Hydro. Method  
☒ Rational  
☐ SCS

**Area Selection / Creation**



Calculate Time of Concentration:



The 'Time of Concentration' dialog box is shown. It includes fields for 'Drainage Area ID' (CB-14) and 'TIN File' (final.tin). Under 'Define Path', there are 'Trace' and 'ID - Segments' buttons. Three flow methods are checked: 'Sheet Flow', 'Shallow Flow', and 'Concentrated Flow'. Each method has its own set of parameters (Method, Length, n Value, Slope, Inter. K, Velocity). At the bottom, 'Accum. Distance' is 292.746 and 'Accum. Avg. Slope' is 1.943. The 'Tc' value is 3.045, which is circled in red. 'Compute' and 'Apply' buttons are at the bottom right.

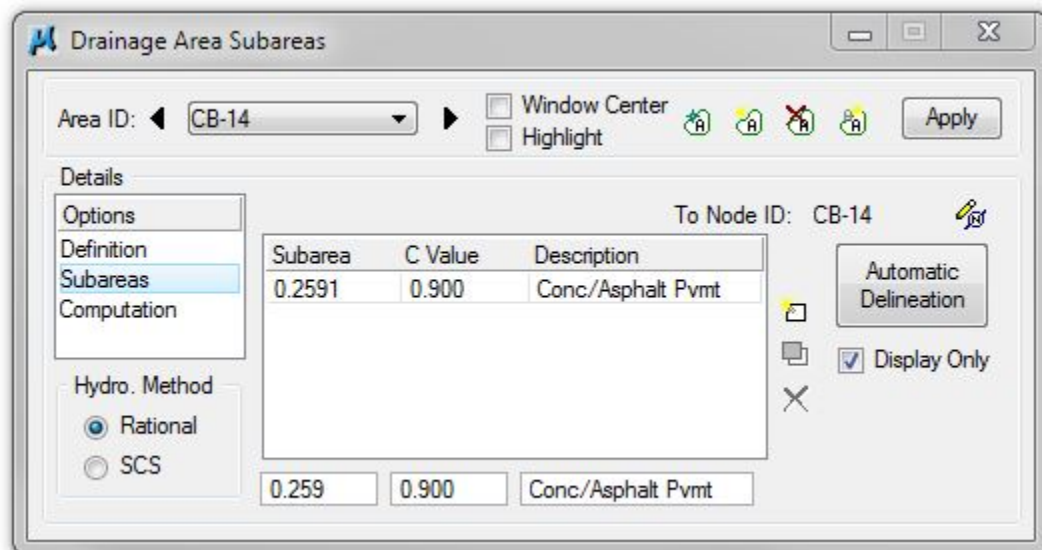
Method	Length	n Value	Slope	Inter. K	Velocity
Sheet Flow	26.000	0.040	1.728		
Shallow Flow	266.746		1.964	0.619	
Concentrated Flow	0.000				5.000

Accum. Distance: 292.746  
Accum. Avg. Slope: 1.943  
**Tc= 3.045**  
Compute Apply

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore **5 must be manually typed** in the Drainage Area Definition dialog after hitting apply in the Time of Concentration Window.

**NOTE:** The maximum length for sheet flow has changed and will vary depending upon the drainage area.

Delineate Subareas utilizing the Land Use DGN:



The 'Drainage Area Subareas' dialog box is shown. It includes a dropdown for 'Area ID' (CB-14) and checkboxes for 'Window Center' and 'Highlight'. A table lists subareas with columns 'Subarea', 'C Value', and 'Description'. The 'To Node ID' is CB-14. There are buttons for 'Automatic Delineation' and 'Display Only'. The 'Hydro. Method' section has 'Rational' selected and 'SCS' unselected. At the bottom, there are input fields for '0.259', '0.900', and 'Conc/Asphalt Pvmnt'.

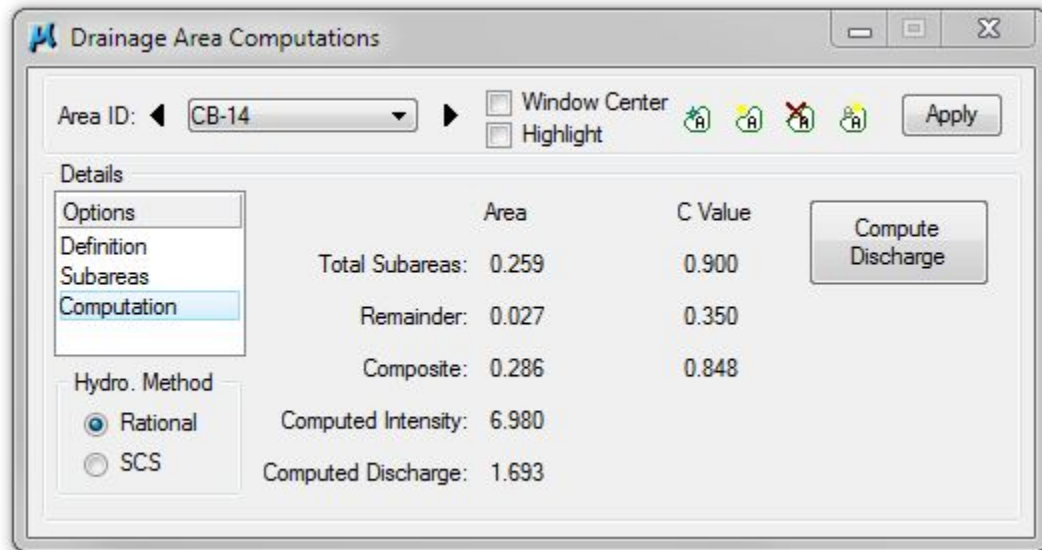
Subarea	C Value	Description
0.2591	0.900	Conc/Asphalt Pvmnt

0.259 0.900 Conc/Asphalt Pvmnt

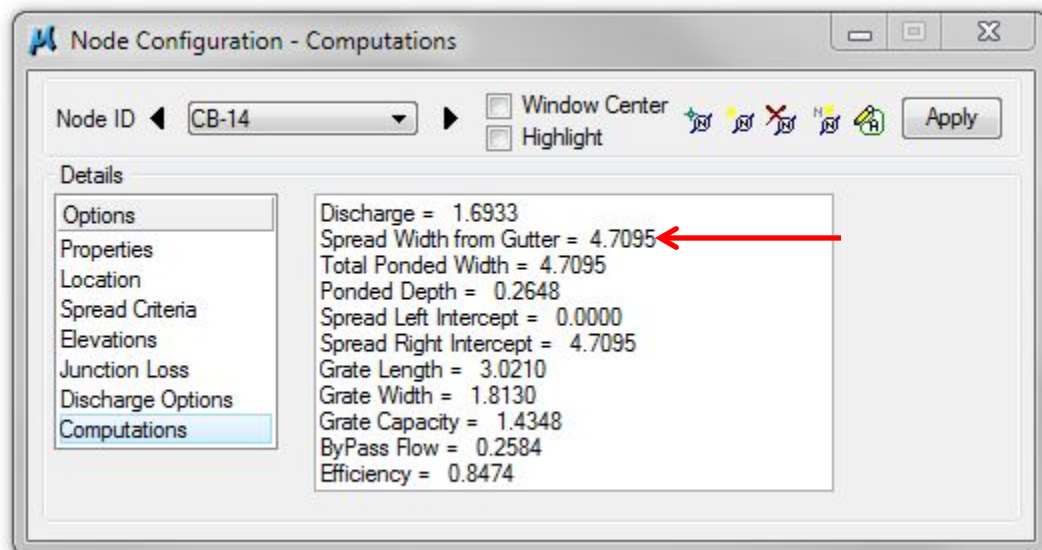


## Exercise 5

Compute Discharge and Apply:



**Step 3.** Back in the **Node Configuration** dialog box click on **Properties**, then click again on **Computations**. This allows the program to update and run calculations. Review the Computations.



Don't be alarmed if your results are off by a few 100<sup>th</sup>'s. It could just be a tolerance issue.

**NOTE:** Upon review of the computations the **Spread Width from Gutter** is within our limit of 8.0 feet, therefore the inlet is in good position.

This is the last catch basin in this network. The curb and gutter section continues and any ByPass will be caught by the next network. If this were not the case, we would need to take steps to capture or mitigate the ByPass Flow.

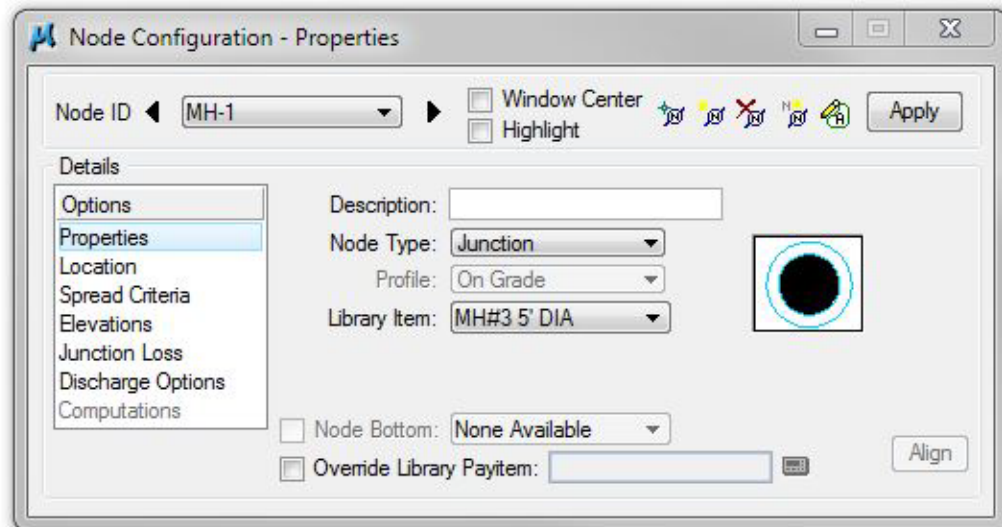
## 5.28 Design Junction MH-1

- Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog. Click **OK** to set the name MH-1

**Properties >** Make the following changes:

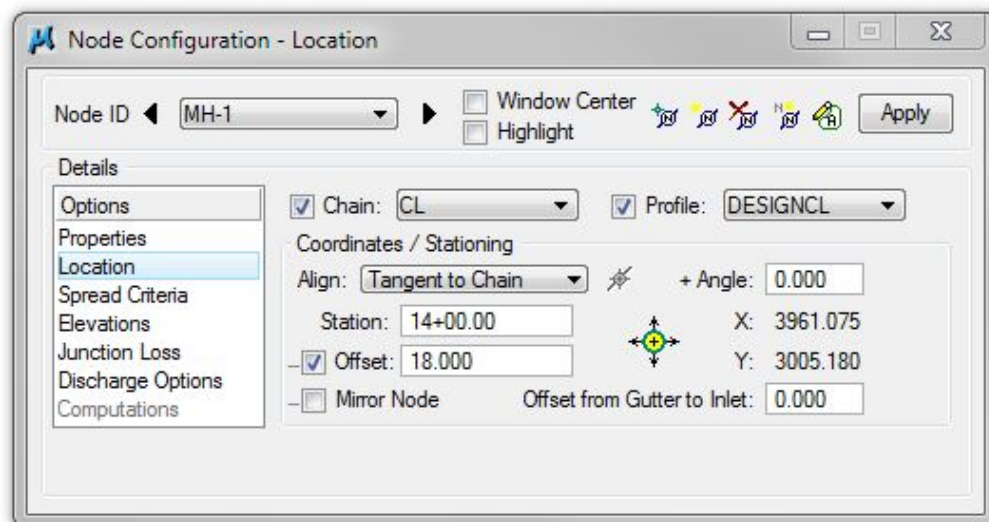
**Node Type:** Junction

**Library Item:** MH#3 5' DIA



**NOTE:** A manhole is used at this location since; a junction is required, the superelevation of the roadway is such that there is little to no flow, and Junction Boxes are not allowed to be used in roadways.

- Step 2. Location >** All Reference information is defaulted from the previous Node (CB-14) such that only the **+ Angle**, **Station** and the **Offset** needs to be changed. Be sure manholes are located out of traffic lanes or out of wheel paths:



## Exercise 5

**Step 3. Elevations** > Elevation Data must be changed to match a **MH#3 5' DIA.** From the [TDOT GEOPAK Drainage Nodes](#) Document set the following:

The screenshot shows the 'Node Configuration - Elevations' dialog box. At the top, the 'Node ID' is set to 'MH-1'. Below this, there are checkboxes for 'Window Center' and 'Highlight', along with several small icons and an 'Apply' button. The 'Details' tab is selected on the left sidebar. The main area contains the following settings:

Property	Value
Reference Surface	TIN File (dropdown), final.tin (text box)
Elevation Source	Reference TIN (dropdown), 861.762 (text box)
Node Elevation Option	Same as Source (dropdown), 861.762 (text box)
Vertical Alignment	Min. Fixed Drop (dropdown), 0.210 (text box)
Minimum Depth	1.830 (text box)
Maximum Depth	40.000 (text box)
Add Sump Depth	0.000 (text box)

**Step 4.** Click the **Apply** button to include this node in the Drainage Project.

## 5.29 Design Outlet EW-1

- Step 1.** Select from the Main Menu Bar: **Component > Node > Add**; or from the Main Toolbar: **Add Drainage Node**; or click the **Add Node** button within the Node Configuration Dialog. Click **OK** to set the name EW-1

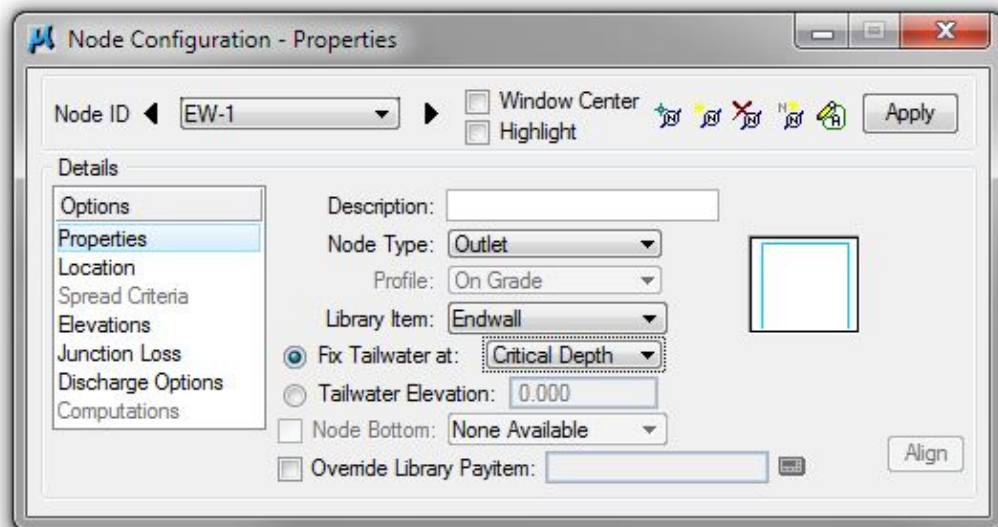
**Properties >** Make the following changes:

**Node Type:** Outlet

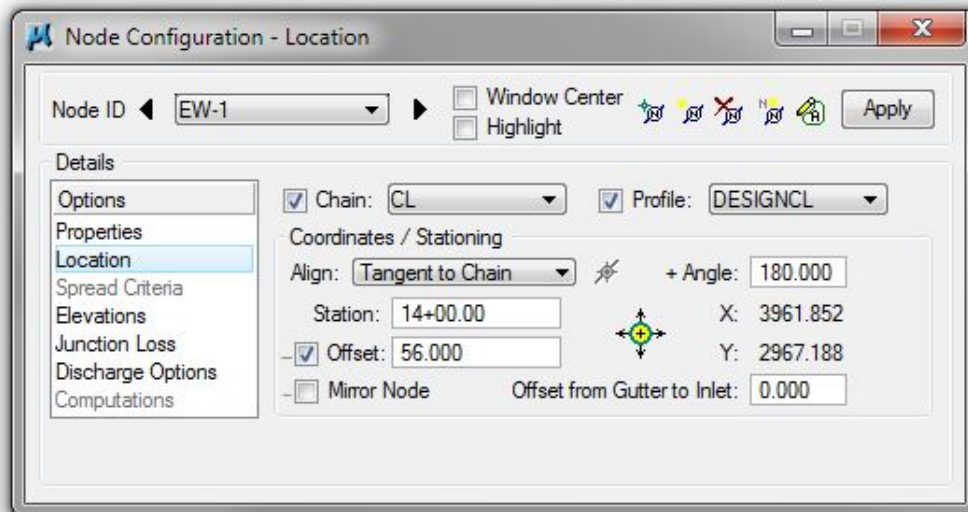
**Library Item:** Endwall

**Fix Tailwater at:** Critical Depth

Other Tailwater options are: Uniform Depth, Soffit (Top of pipe), or Elevation: User input (known elevation)



- Step 2.** **Location >** All Reference information is defaulted from the previous Node (CB-14) such that only the **+ Angle**, **Station** and the **Offset** needs to be changed. Angle is critical as to direction node will be displayed.



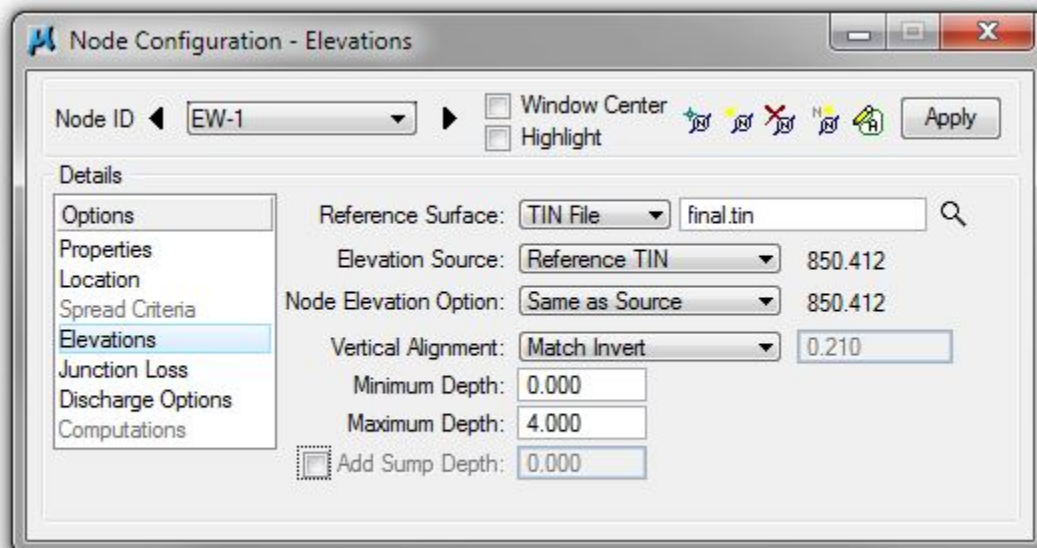
## Exercise 5

**Step 3. Elevations** > Change the Elevation data to the following:

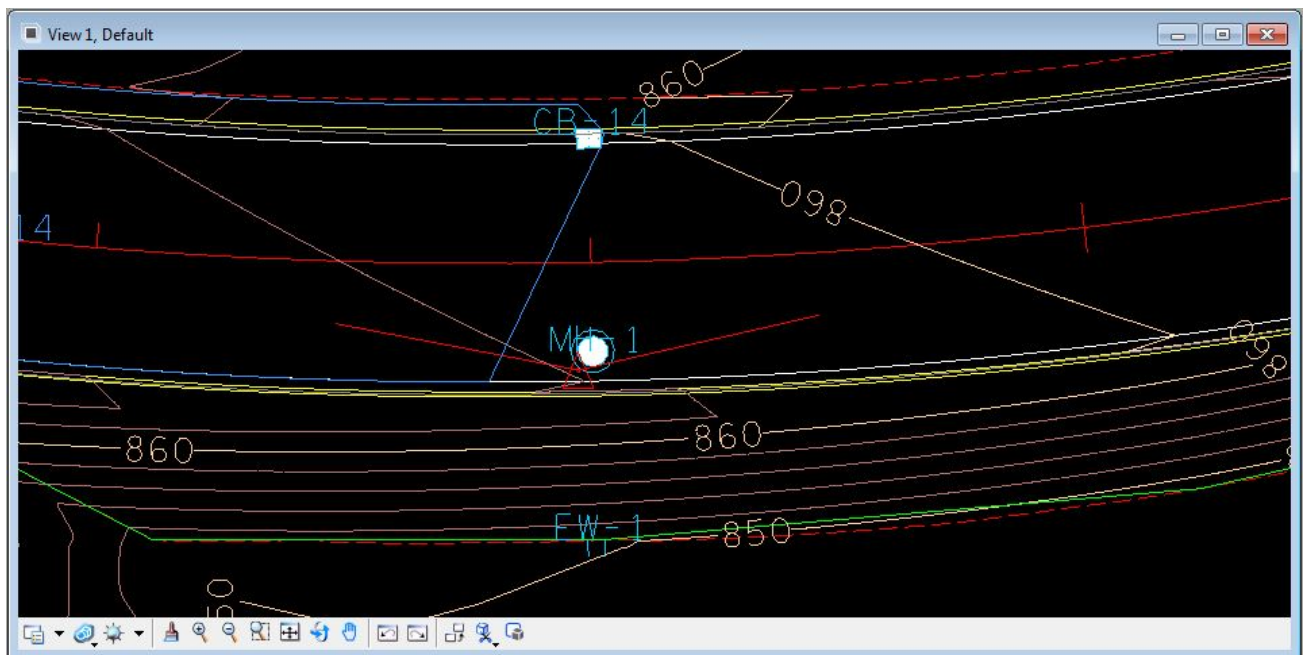
**Vertical Alignment:** Match Invert

**Minimum Depth:** 0.000

**Maximum Depth:** 4.000



**NOTE:** This is a preliminary location used to determine outlet elevation, etc. This node will need to be adjusted to account for the side slope, endwall and the final pipe size which is designed.



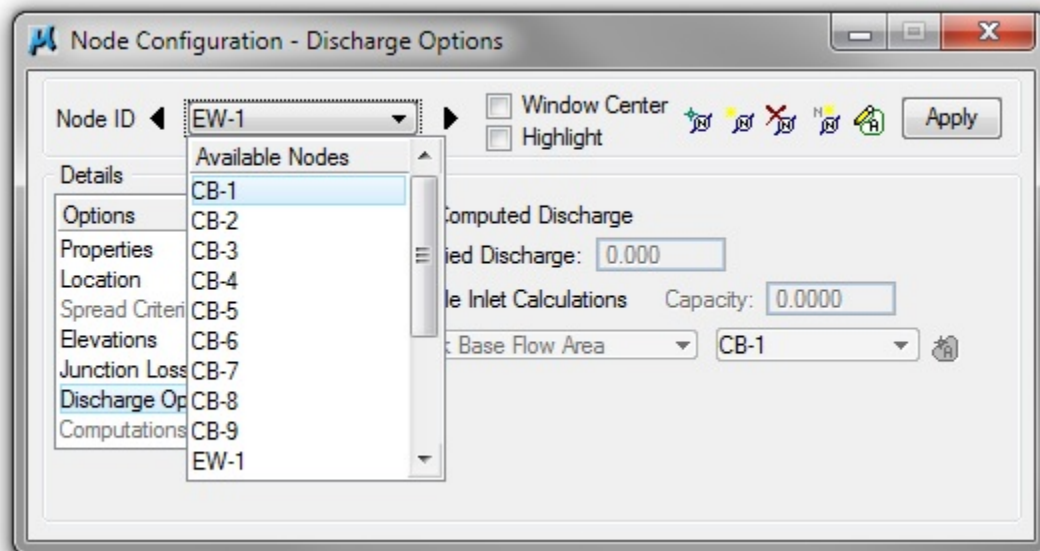
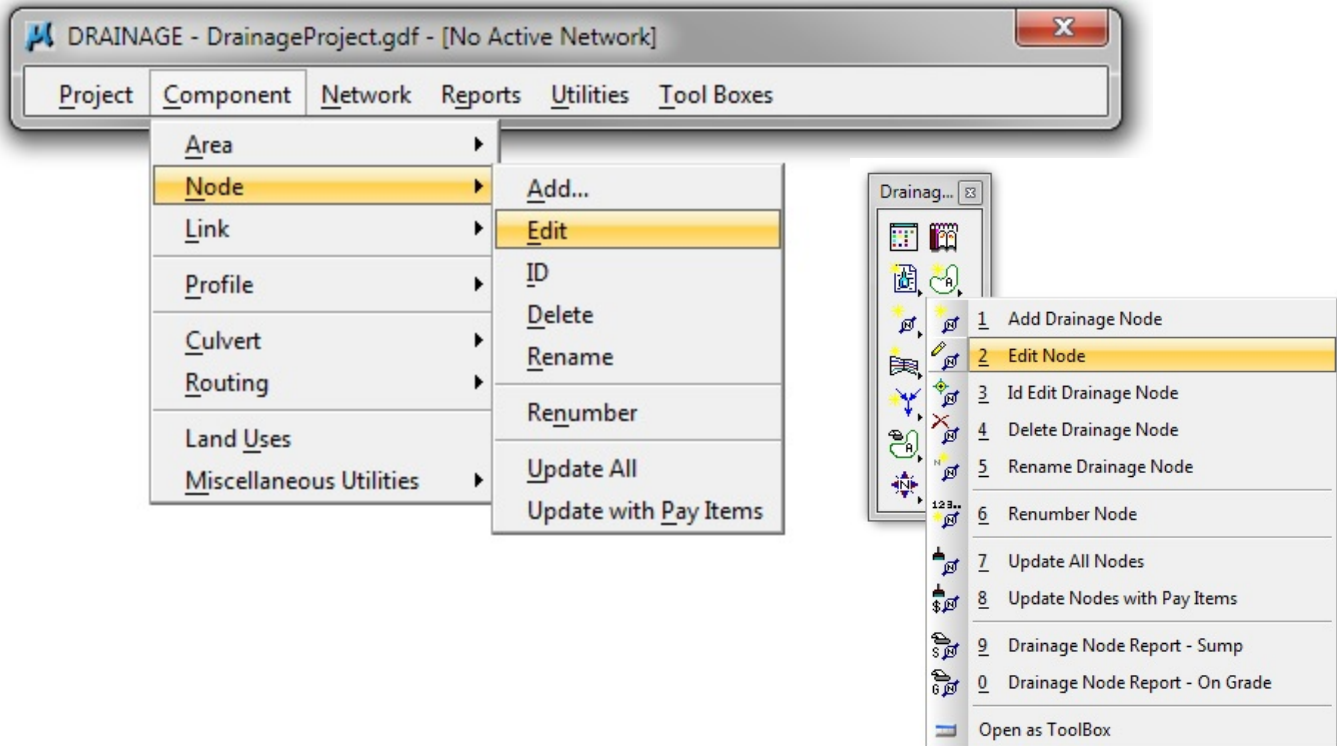
**Step 4.** Click the **Apply** button to include this node in the Drainage Project.



## 5.30 Inlet Bypass

Set the Inlet bypass as required to bypass flow to the downstream inlets.

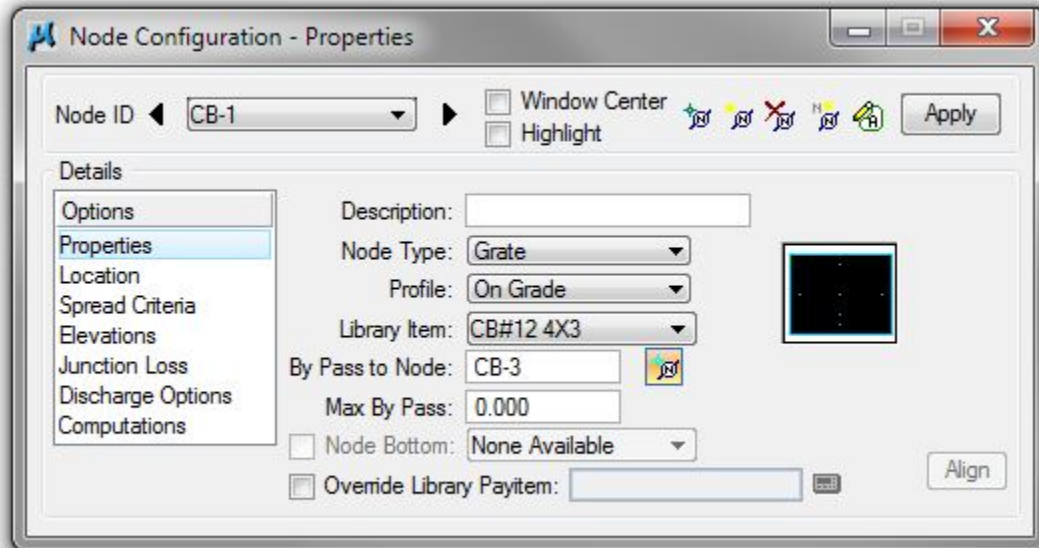
**Step 1.** Select **Component > Node > Edit** or choose from the Tool Box and use the drop-down menu to select CB-1.



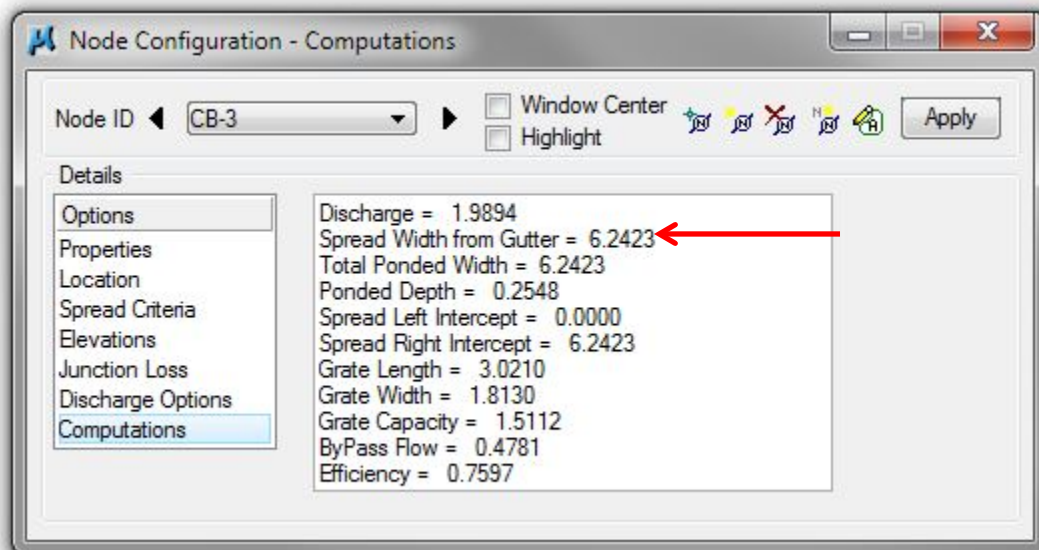
## Exercise 5

**Step 2. Properties >** Keyin the **By Pass to Node** as CB-3 or click the **ID** button and data point on the node in the plan view.

The Bypass flow from this inlet will then contribute its resulting bypass flow to CB-3. Click the **Apply** button to accept the changes.



**Step 3. Select CB-3, Computations >** Review the computations to make sure the spread is still within the design limits.



**Step 4.** Follow the same procedures to bypass the remaining flow to the inlets as described in the table below:

Node ID	By Pass to Node
CB-2	CB-4
CB-3	CB-6
CB-4	CB-9
CB-6	CB-12
CB-9	CB-11
CB-11	CB-13
CB-12	CB-14
CB-13	CB-14

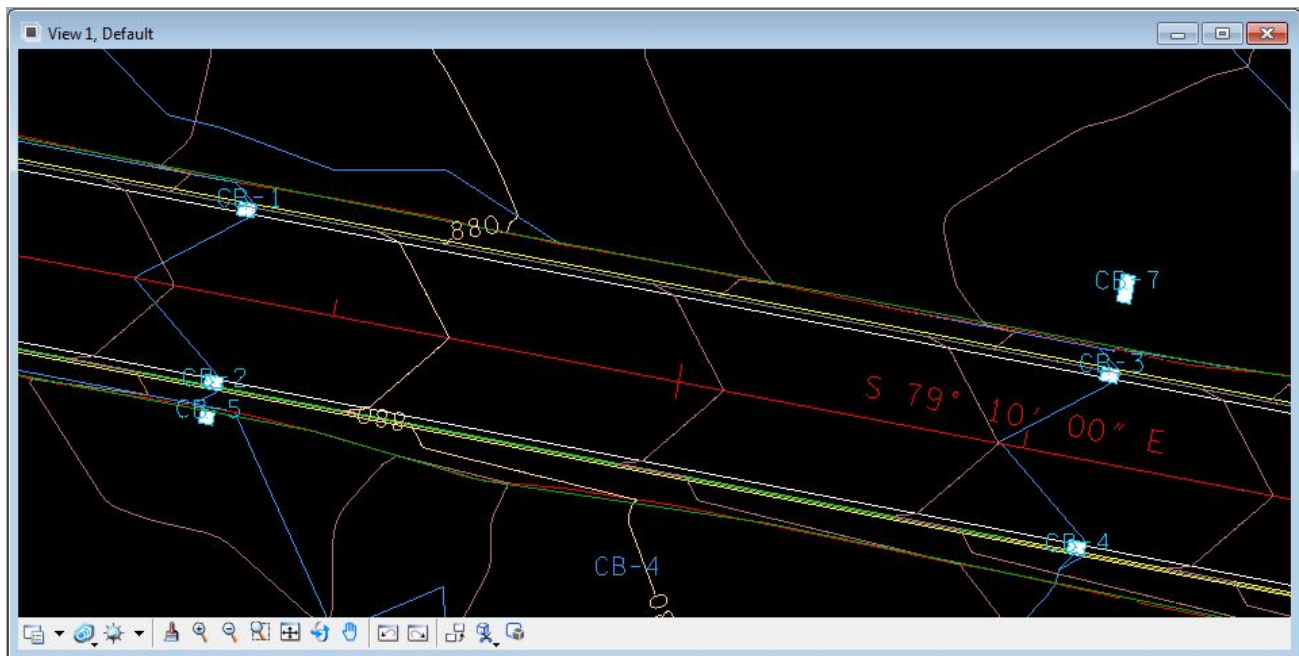
**NOTE:** After adding ByPass flow to CB-13, the spread exceeds our limit of 8.0'. Either CB-13 would need to be moved and recalculated to reduce the spread or an additional catch basin would need to be added.

## Storm Drainage Links

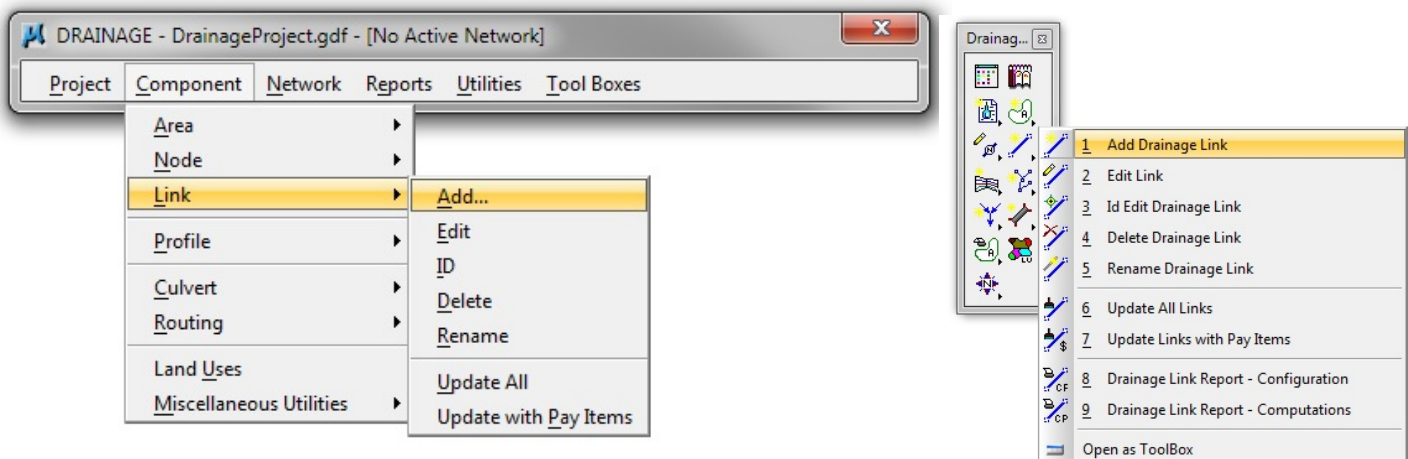
This exercise shows the user how to utilize the tools necessary for connecting the surface drainage (inlets) to the collection system (pipes). The user will design the storm drainage pipes for this project.

### 6.1 Link Design

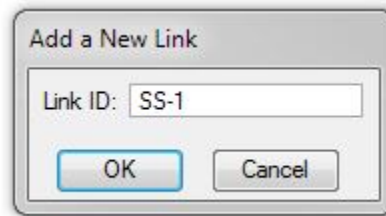
**Step 1.** Visually determine the tentative location of the first storm drainage pipe. This link will connect Nodes CB-1 and CB-3.



**Step 2.** Select from the Drainage Menu Bar: **Component > Link > Add** or from the main toolbar: **Add Drainage Link**:



**Step 3.** In the **New Link** window that appears, click OK to set the name **SS-1**



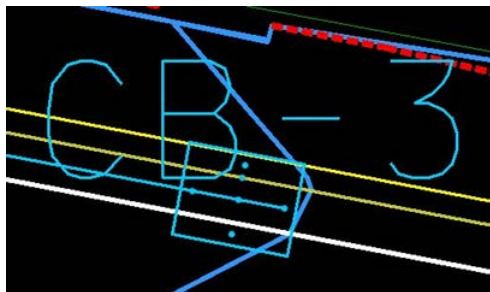
**Step 4. Definition >** This dialog sets the pipe configuration including: From Node, To Node, Shape, Material, Library Item, etc.

There are two ways to set the Nodes: from the dropdown list or graphically selecting the Nodes. Graphically is recommended to ensure the correct pipe connection points are utilized. See note concerning these below.

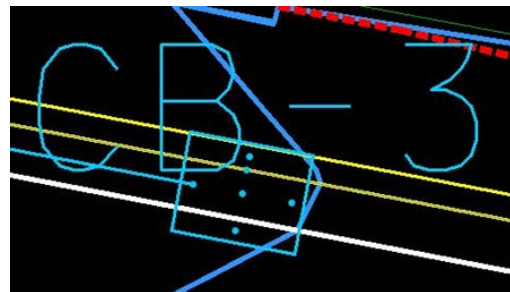
To select graphically click the **ID**  button for each and identify the correct Node. SS-1 traverses **From Node CB-1 To Node CB-3**:

**NOTE:** All drainage nodes include pipe connection points on the structures (for circular structures there are NOT single points but an entire circle for connection). When a drainage node is identified for connection it will use the nearest face to the identification Data Point. **Therefore it is important to Zoom in close enough to drainage nodes and identify them at the correct connection point of the structure.** Correct and Incorrect examples are shown below.

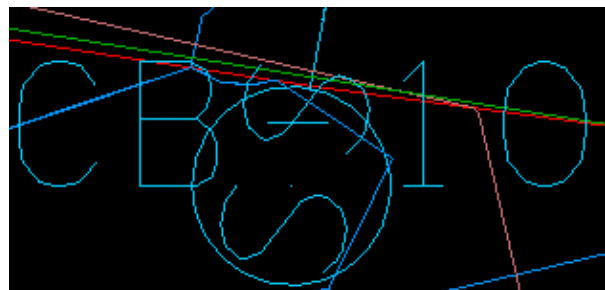
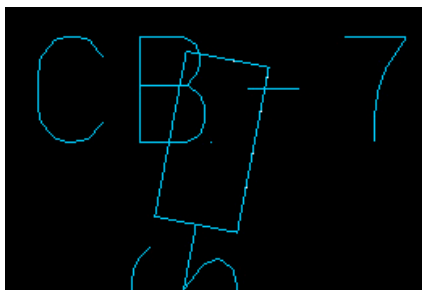
**INCORRECT**



**CORRECT**



The symbolization for drop inlets display the full extent of the sub-structure as opposed to the normal smaller symbol used for curb and gutter inlets. This done so that the designer can ensure adequate R.O.W. or easement is provided. For this reason you will **not** see the pipe connection points for these structures since they coincide with the structure wall as shown below.





## Exercise 6

Set the remaining Link Configurations as follows:

**Shape:** Circular

**Material:** Concrete

**Design Size:** Toggle ON

**Design Barrels:** Toggle OFF

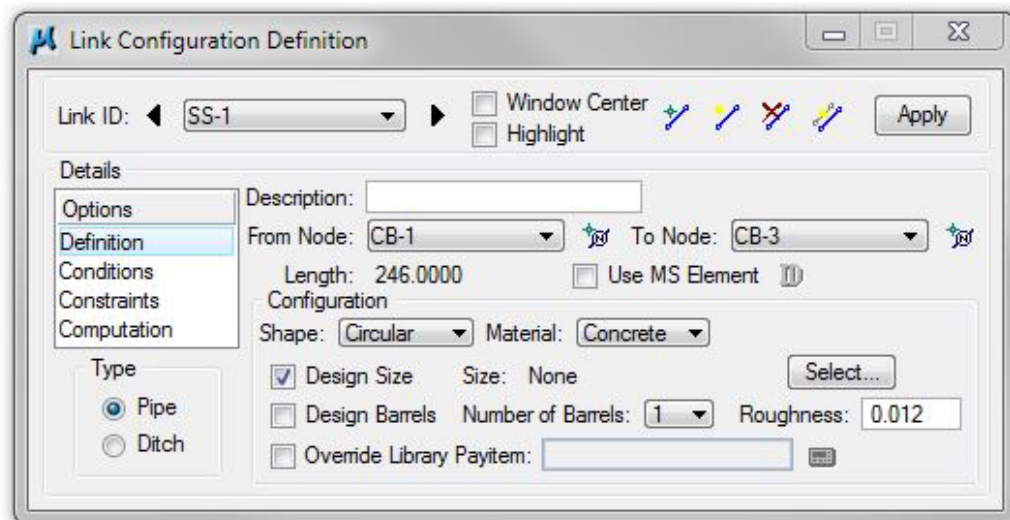
**Number of Barrels:** 1

**Roughness:** Automatically set based on the selected Material

### NOTES:

Multiple barrels could be designed, if required, by toggling **Design Barrels ON** or setting **Number of Barrels** to the determined number.

If the link size is known, it may be input by toggling **Design Size OFF** and clicking on the **Select...** button.



**Step 4. Conditions** > The elevations shown are based on the Node Elevation minus the min/max depth. These depths were specified in the **Node Definition** (See Exercise 5) Dialog Box for Nodes CB-1 (From Node) and CB-3 (To Node) respectively. In this case, no entries are necessary and GEOPAK Drainage will design all the profiles for this project.

Link Configuration Conditions

Link ID: SS-1

☐ Window Center ☐ Highlight

Apply

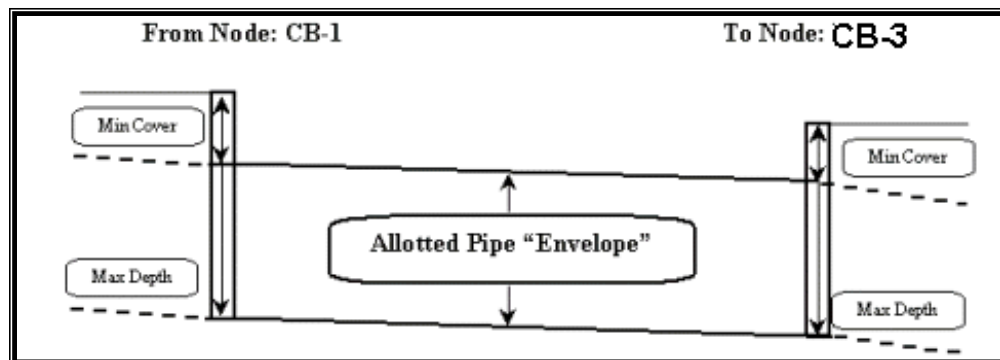
Details

Options  
Definition  
Conditions  
Constraints  
Computation

Type  
☒ Pipe  
☐ Ditch

Profile Conditions

	From Node	Slope	To Node
Min Cover:	878.590	2.447	872.471
Soffit:	0.000 <input type="checkbox"/>	0.000 <input type="checkbox"/>	0.000 <input type="checkbox"/>
Invert:	0.000 <input type="checkbox"/>		0.000 <input type="checkbox"/>
Max Depth:	860.970	2.515	854.681



**NOTE:** When **manually** defining Invert elevations for links, make sure the drop across a structure is accounted for. In other words, if you were to define the Invert elevations for Links SS-1 and SS-3 at CB-3, then make sure the **From Node Invert** elevation for Link SS-3 is at least the minimum drop lower than the **To Node Invert** elevation for Link SS-1.

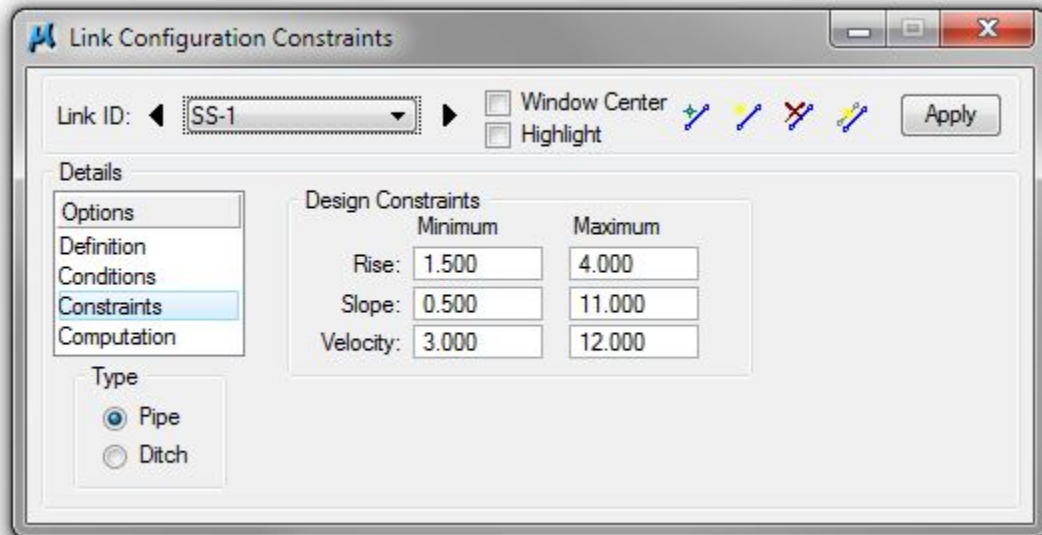
## Exercise 6

**Step 5. Constraints >** Establish the min/max design criteria for Links as follows:

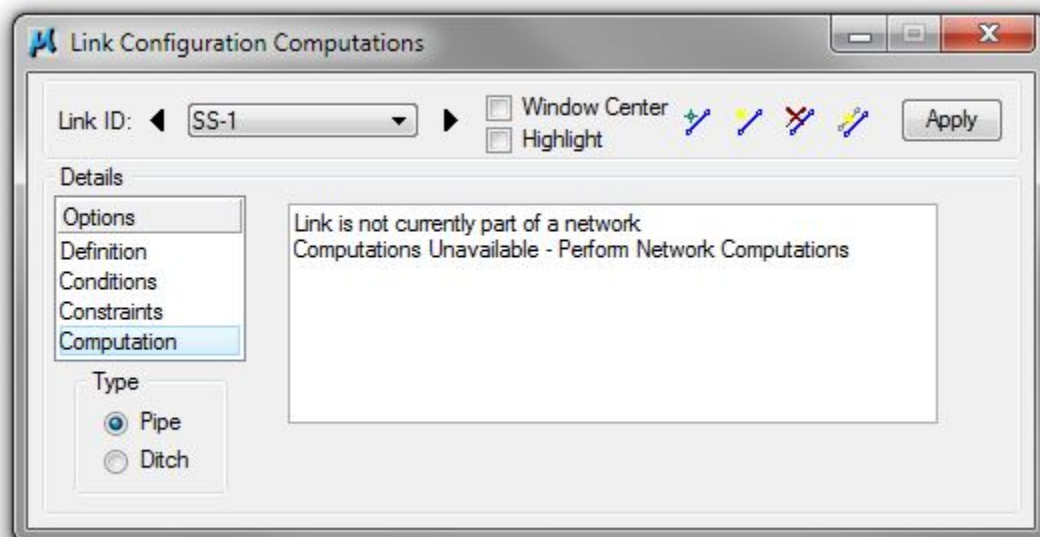
**Rise Min/Max:** 1.5 / 4.0 (feet)

**Slope Min/Max:** 0.50 / 11.00 (%)

**Velocity Min/Max:** 3.00 / 12.00 (fps)

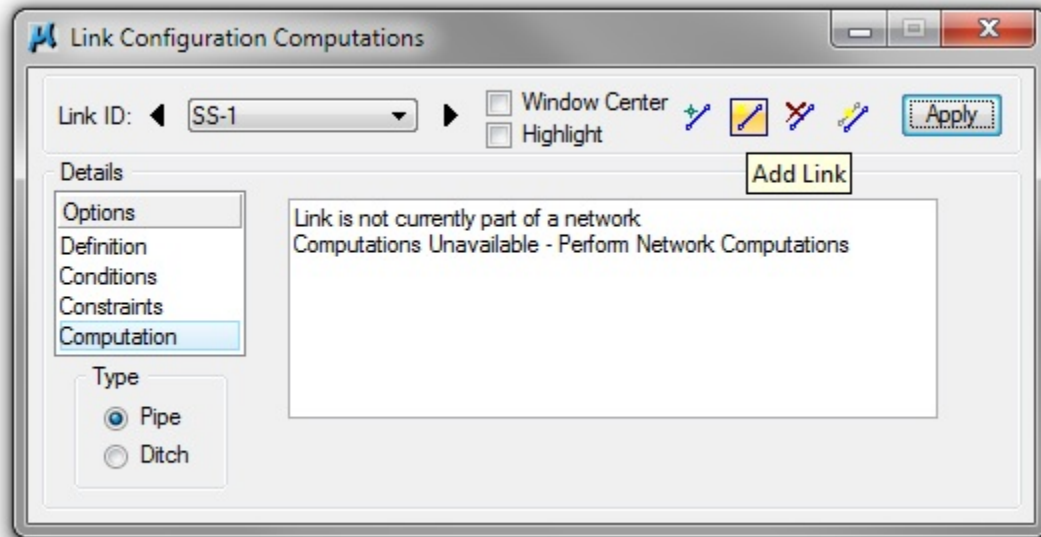


**Step 6. Computations >** Displays the computed hydraulic properties of the Link.



**NOTE:** Link hydraulics are not available for review until a Network has been established and designed or analyzed successfully (See Exercise 8). Check back here for computations after the Network has been added and designed or analyzed.

- Step 7.** Click the **Apply** button to include this Link in the drainage project.
- Step 8.** **Add** the remainder of the link conveyance system using **Component > Link > Add** from the Drainage Menu Bar or by clicking the **Add Link** button as shown below.



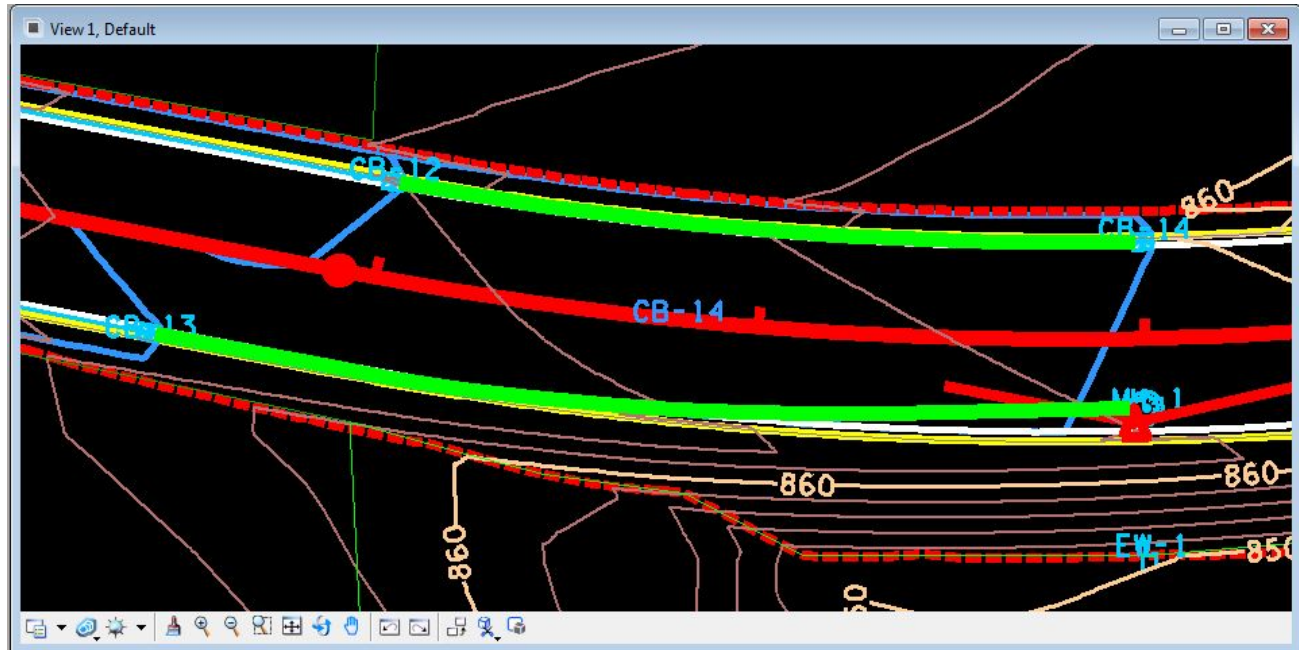
As Links are added, most dialog values default from the previous Link with the exception of **From Node** and **To Node**. Add Links between all of the following Nodes:

Link SS-2 Traverses From Node <u>CB-2</u> To Node <u>CB-4</u>
Link SS-3 Traverses From Node <u>CB-3</u> To Node <u>CB-6</u>
Link SS-4 Traverses From Node <u>CB-4</u> To Node <u>CB-9</u>
Link SS-5 Traverses From Node <u>CB-5</u> To Node <u>CB-2</u>
Link SS-6 Traverses From Node <u>CB-6</u> To Node <u>CB-12</u>
Link SS-7 Traverses From Node <u>CB-7</u> To Node <u>CB-3</u>
Link SS-8 Traverses From Node <u>CB-8</u> To Node <u>CB-6</u>
Link SS-9 Traverses From Node <u>CB-9</u> To Node <u>CB-11</u>
Link SS-10 Traverses From Node <u>CB-10</u> To Node <u>CB-9</u>
Link SS-11 Traverses From Node <u>CB-11</u> To Node <u>CB-13</u>
<b>**Link SS-12 Traverses From Node <u>CB-12</u> To Node <u>CB-14</u>**</b>
<b>**Link SS-13 Traverses From Node <u>CB-13</u> To Node <u>MH-1</u>**</b>
Link SS-14 Traverses From Node <u>CB-14</u> To Node <u>MH-1</u>
Link SS-MH1 Traverses From Node <u>MH-1</u> To Node <u>EW-1</u>

**\*\* See notes on next page \*\***

## 6.2 Curved Links

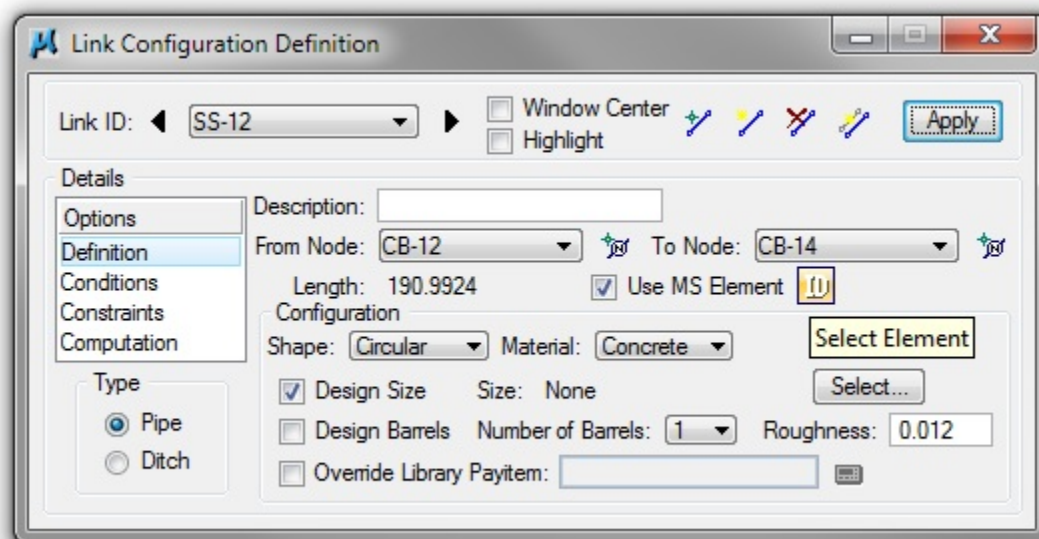
- Step 1.** Use MicroStation Tools to draw a curved element (must be a continuous line string) between the nodes and following the middle of the gutter to the extent possible.



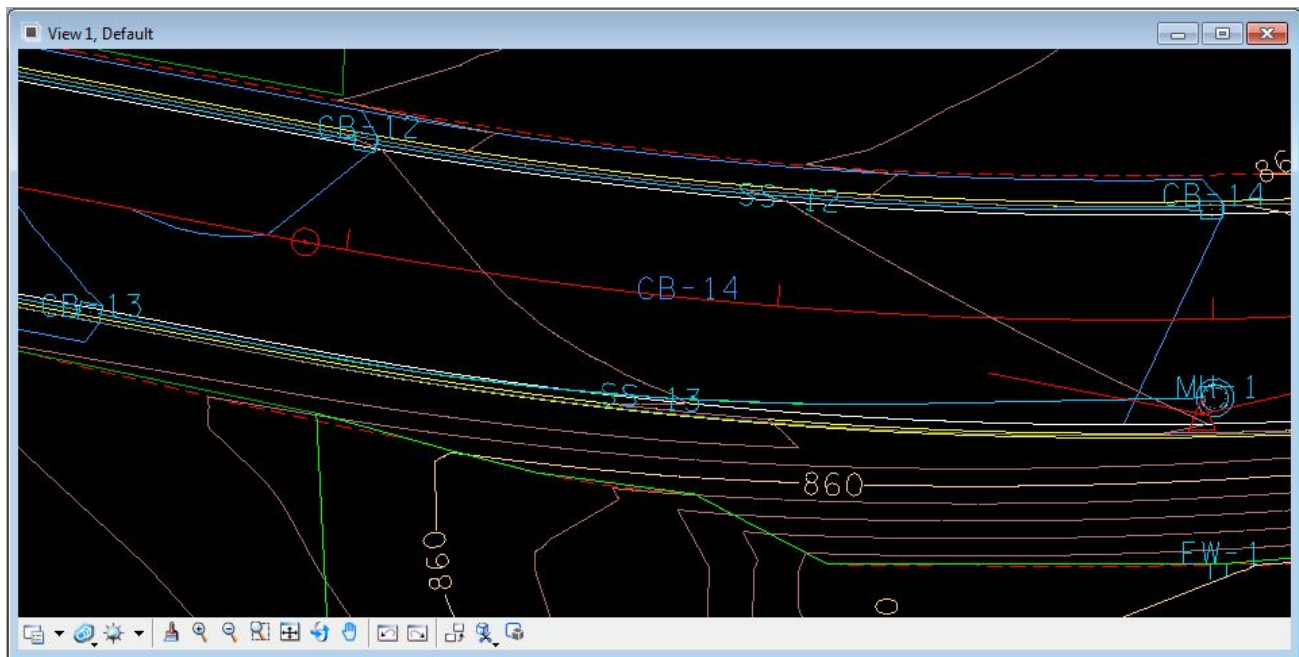
**NOTE:** Make sure the ends of the MicroStation Element terminate at the correct attachment point on the catch basin.

- Step 2.** In the **Link Configuration Definition** dialog toggle **ON** **Use MS Element**.

- Step 3.** Click the Select Element button then Data Point on the element created in **Step 1**. Then click **Apply**.







**NOTE:** Be sure to toggle **Use MS Element** OFF for subsequent Links that are not curved. When used, the Link position and length are defined by the MS Element. **Caution must be used** in order to properly define the Link.

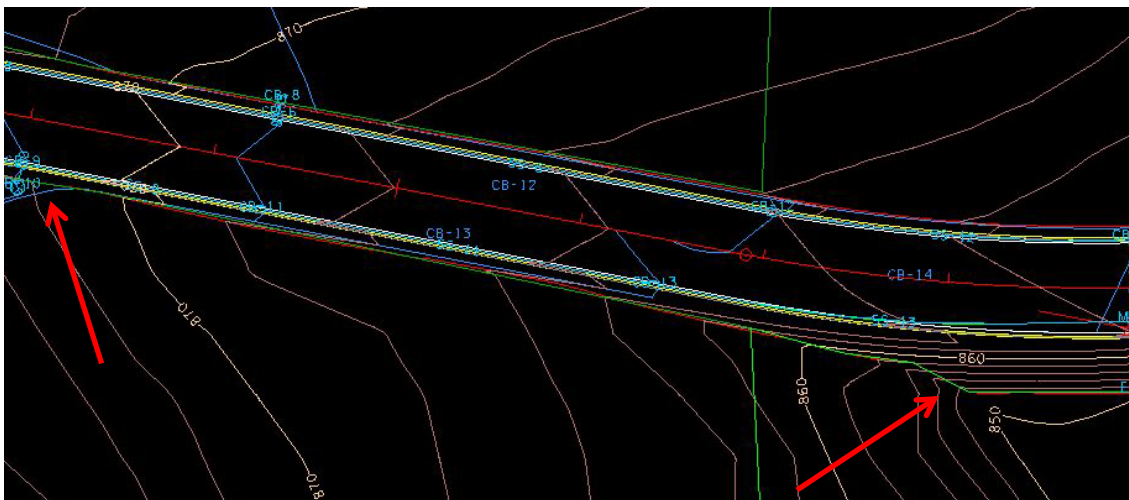
## Ditch Nodes and Links

This exercise shows the user how to utilize the tools for nodes and links for ditch analysis. We will investigate the drainage flow along a fill slope with these settings and in a later chapter define a special ditch to manage it.

### 7.1 Node Design

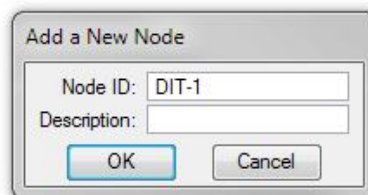
#### Begin Ditch

**Step 1.** Visually determine the tentative location of the beginning of the ditch. In this case a ditch is created along the south side of the roadway by the new fill slopes.

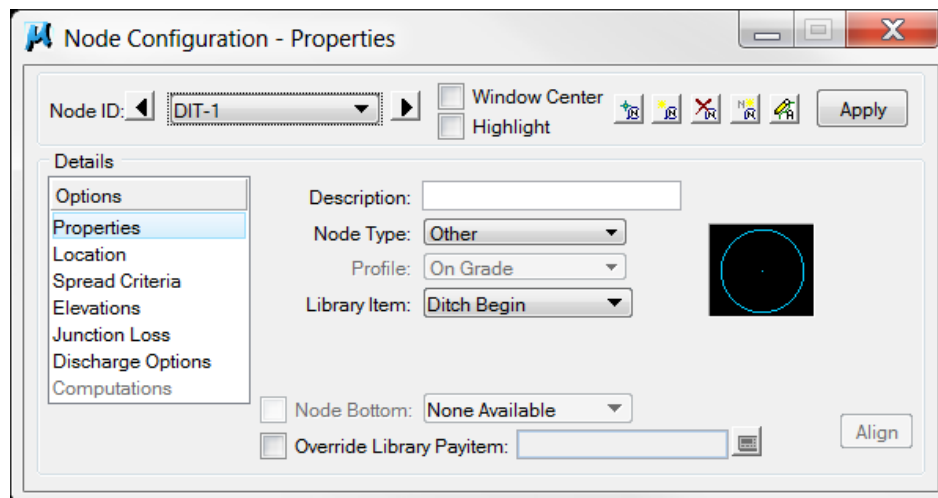


**Step 2.** Select from the Drainage Menu Bar: **Component > Node > Add** or from the main toolbar: **Add Drainage Node**.

**Step 3.** In the **New Node** window that appears, set the name **DIT-1** and click **OK**.



**Step 4. Properties > Set Node Type to Other and Library Item to Ditch Begin.**



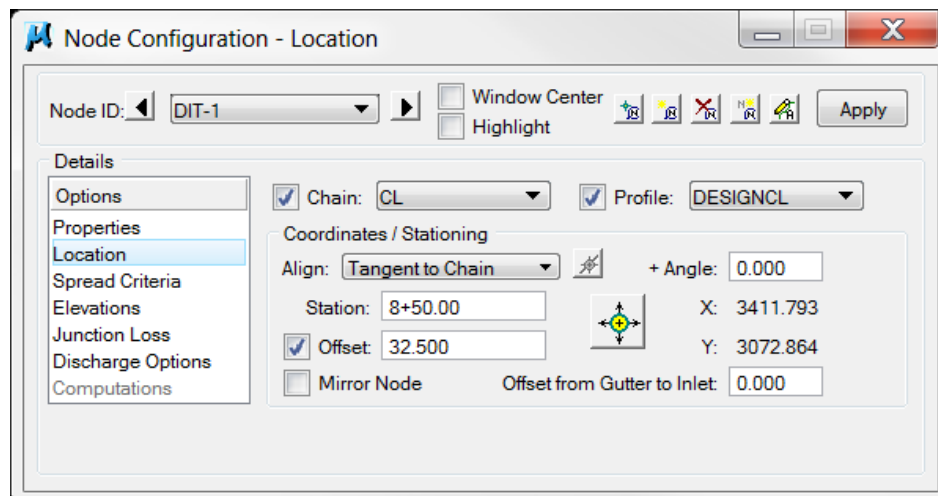
The 'Node Configuration - Properties' dialog box is shown. The 'Node ID' is 'DIT-1'. The 'Node Type' is set to 'Other' and the 'Library Item' is 'Ditch Begin'. The 'Profile' is 'On Grade'. The 'Node Bottom' is 'None Available'. The 'Override Library Payitem' is empty. The 'Details' tab is selected, and the 'Properties' sub-tab is active. The 'Description' field is empty. The 'Align' button is visible.

**Step 5. Location > All settings should have carried over from the last Node input. Review and make the following changes:**

**Station: 8+50.00**

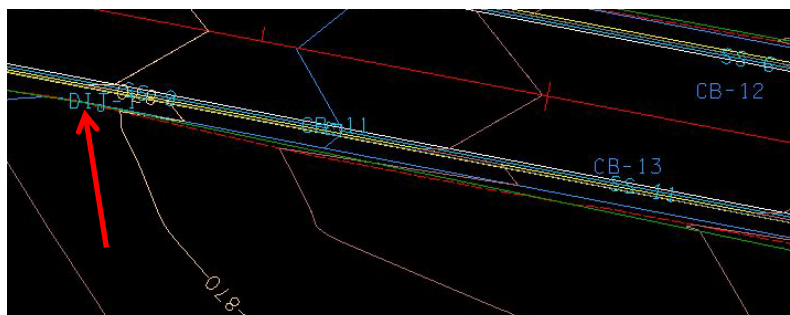
**Offset: 32.50**

**+Angle: 0.00**



The 'Node Configuration - Location' dialog box is shown. The 'Node ID' is 'DIT-1'. The 'Chain' is 'CL' and the 'Profile' is 'DESIGNCL'. The 'Coordinates / Stationing' section shows 'Align' as 'Tangent to Chain', 'Station' as '8+50.00', 'Offset' as '32.500', and '+ Angle' as '0.000'. The 'X' coordinate is '3411.793' and the 'Y' coordinate is '3072.864'. The 'Mirror Node' checkbox is unchecked. The 'Offset from Gutter to Inlet' is '0.000'. The 'Details' tab is selected, and the 'Location' sub-tab is active.

This will approximate the beginning of the ditch as shown below:



## Exercise 7

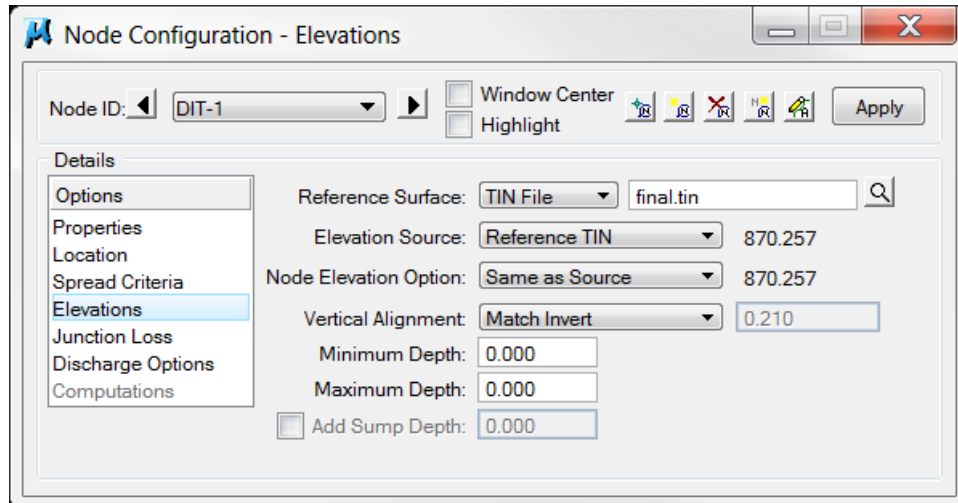
**NOTE:** The **Spread Criteria** configuration is not required for the **Other** node types such as are used by ditches.

**Step 6. Elevations >** All settings should have carried over from the last Node input. Review and make the following changes:

**Vertical Alignment:** Match Invert

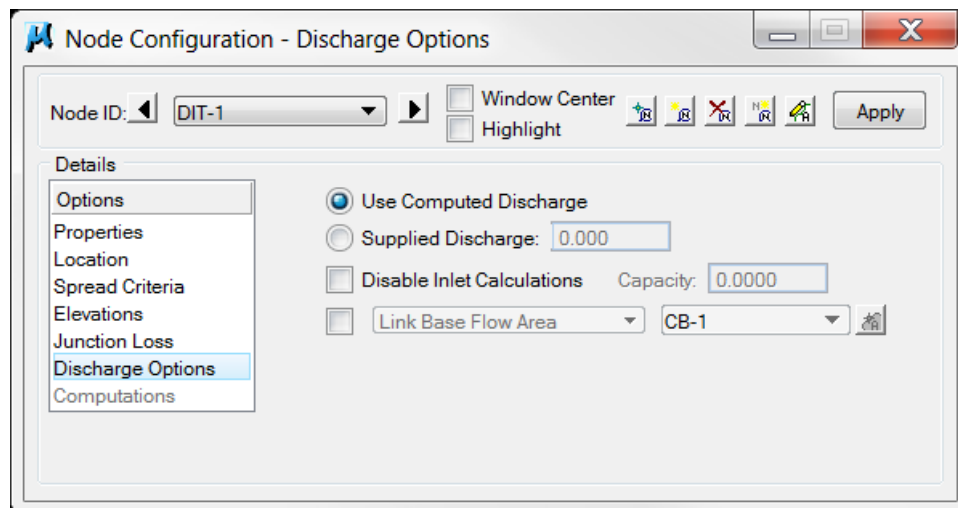
**Minimum Depth:** 0.00

**Maximum Depth:** 0.00



The image shows the 'Node Configuration - Elevations' dialog box. The 'Node ID' is 'DIT-1'. The 'Reference Surface' is 'TIN File' with 'final.tin' selected. The 'Elevation Source' is 'Reference TIN' with a value of 870.257. The 'Node Elevation Option' is 'Same as Source' with a value of 870.257. The 'Vertical Alignment' is 'Match Invert' with a value of 0.210. The 'Minimum Depth' is 0.000. The 'Maximum Depth' is 0.000. The 'Add Sump Depth' checkbox is unchecked with a value of 0.000. The 'Details' pane on the left shows 'Elevations' selected.

**Step 7. Discharge Options >** Leave **Use Computed Discharge** selected and click **Apply** to save all settings.



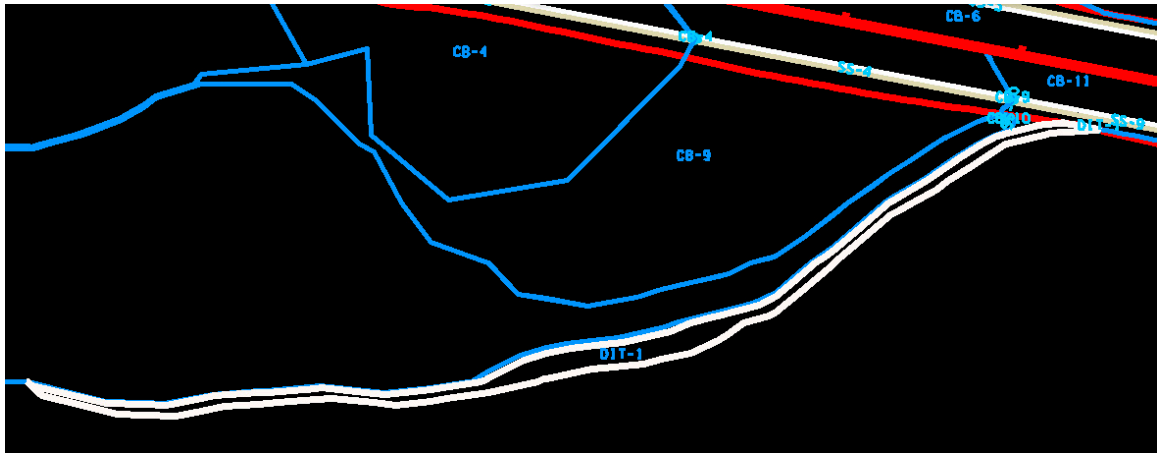
The image shows the 'Node Configuration - Discharge Options' dialog box. The 'Node ID' is 'DIT-1'. The 'Use Computed Discharge' radio button is selected. The 'Supplied Discharge' is 0.000. The 'Disable Inlet Calculations' checkbox is unchecked with a 'Capacity' of 0.0000. The 'Link Base Flow Area' dropdown is set to 'CB-1'. The 'Details' pane on the left shows 'Discharge Options' selected.

**NOTE:** For short ditches where only a single drainage area is utilized, the **Link Base Flow Area** option should be toggled ON and set to add the discharge for that area. It is then toggled off at the ditch outlet. If this is not toggled OFF at other nodes beyond the beginning the discharge will accumulate at each node and not accurately represent the area's discharge.

## Begin Ditch Drainage Area

- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **DIT-1** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for the begin ditch location. (You may use the following images as reference points. It is ok if your numbers do not match exactly.)

Delineate Drainage Area:



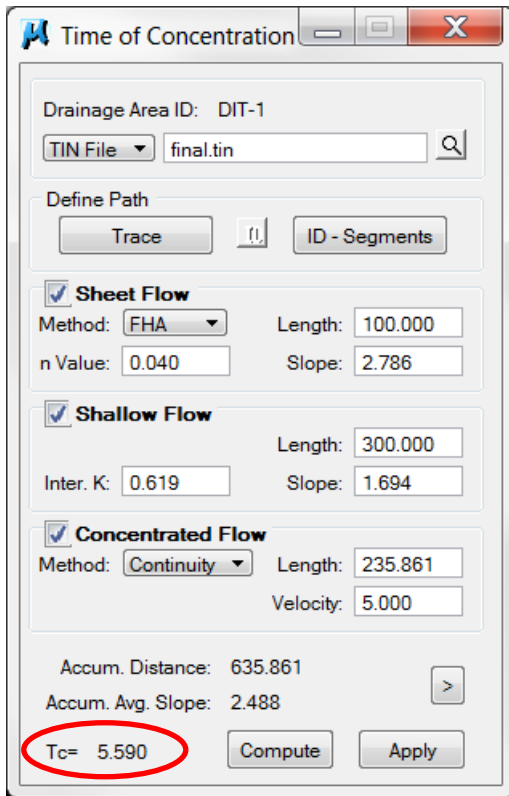
**NOTE:** The drainage area should be broken into sections for long ditches, however, for short ditches; determine the area from the most downstream point (i.e. the stream outlet).

Define Drainage Area:



## Exercise 7

Calculate Time of Concentration:

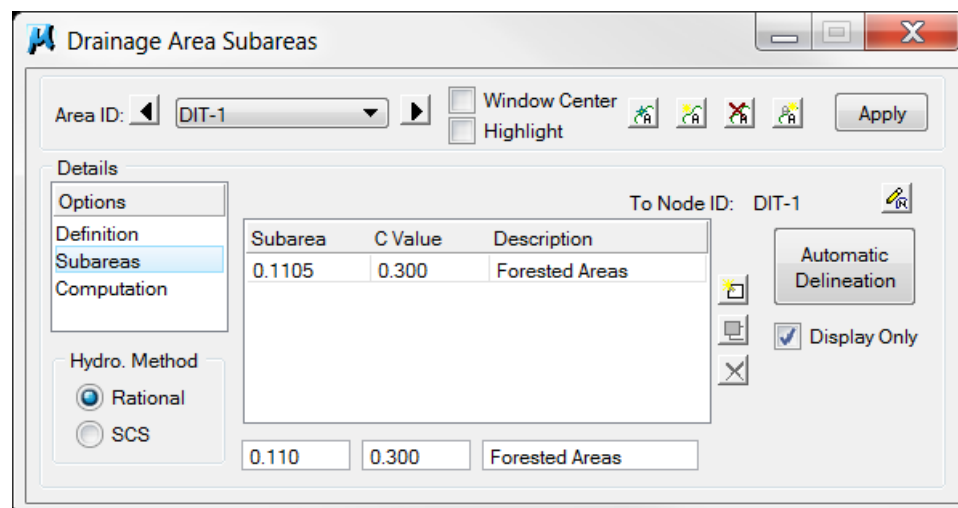


The dialog box 'Time of Concentration' is shown. It contains the following fields and controls:

- Drainage Area ID: DIT-1
- TIN File: final.tin
- Define Path: Trace, ID - Segments
- Sheet Flow: Method: FHA, Length: 100.000, n Value: 0.040, Slope: 2.786
- Shallow Flow: Length: 300.000, Inter. K: 0.619, Slope: 1.694
- Concentrated Flow: Method: Continuity, Length: 235.861, Velocity: 5.000
- Accum. Distance: 635.861
- Accum. Avg. Slope: 2.488
- Tc= 5.590 (circled in red)
- Buttons: Compute, Apply

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required

Delineate Subareas utilizing the Land Use DGN:



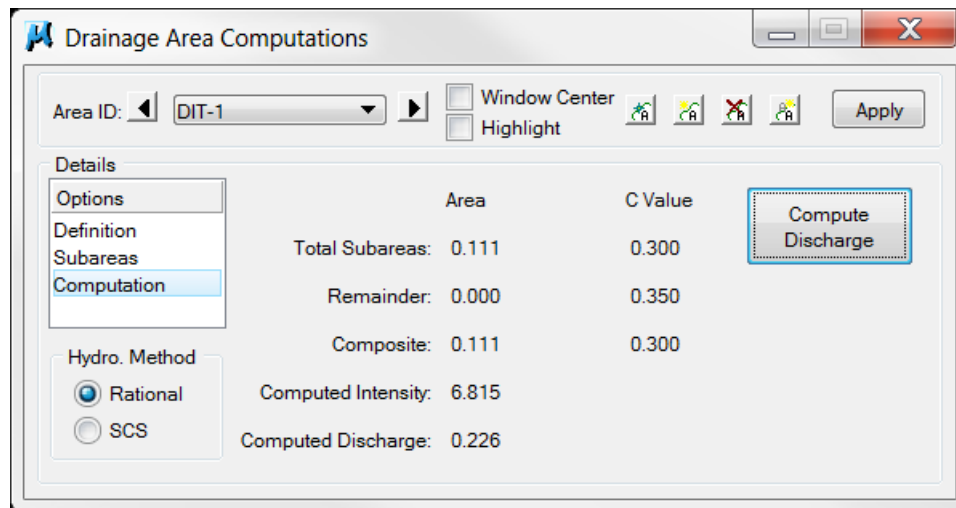
The dialog box 'Drainage Area Subareas' is shown. It contains the following fields and controls:

- Area ID: DIT-1
- Window Center, Highlight (checkboxes)
- Apply button
- Details: Options, Definition, Subareas (selected), Computation
- To Node ID: DIT-1
- Automatic Delineation button
- Display Only (checkbox)
- Hydro. Method: Rational (selected), SCS
- Table with 3 columns: Subarea, C Value, Description

Subarea	C Value	Description
0.1105	0.300	Forested Areas

Below the table, there are input fields for Subarea (0.110), C Value (0.300), and Description (Forested Areas).

Compute Discharge and Apply:



The image shows a software dialog box titled "Drainage Area Computations". At the top, there is a window control bar with minimize, maximize, and close buttons. Below this, the "Area ID" is set to "DIT-1". To the right of the Area ID are checkboxes for "Window Center" and "Highlight", and a row of four small icons representing different map views. An "Apply" button is located to the right of these icons. On the left side, there is a "Details" section with a list box containing "Options", "Definition", "Subareas", and "Computation", where "Computation" is currently selected. Below the list box is a "Hydro. Method" section with two radio buttons: "Rational" (which is selected) and "SCS". The main area of the dialog displays a table of computed values. The table has two columns: "Area" and "C Value". The rows are: "Total Subareas: 0.111" with a "C Value" of "0.300", "Remainder: 0.000" with a "C Value" of "0.350", and "Composite: 0.111" with a "C Value" of "0.300". Below the table, the "Computed Intensity" is "6.815" and the "Computed Discharge" is "0.226". A "Compute Discharge" button is located to the right of the table, highlighted with a dashed border.

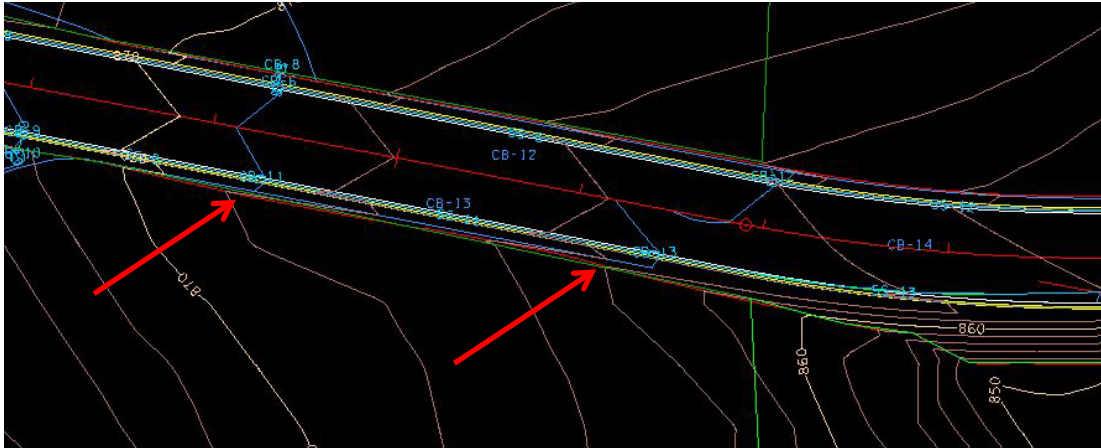
	Area	C Value
Total Subareas:	0.111	0.300
Remainder:	0.000	0.350
Composite:	0.111	0.300

Computed Intensity: 6.815  
Computed Discharge: 0.226

## Ditch Change

**Step 1.** Visually determine the location of any major ditch change; such as a change in horizontal or vertical alignment or a change in cross section.

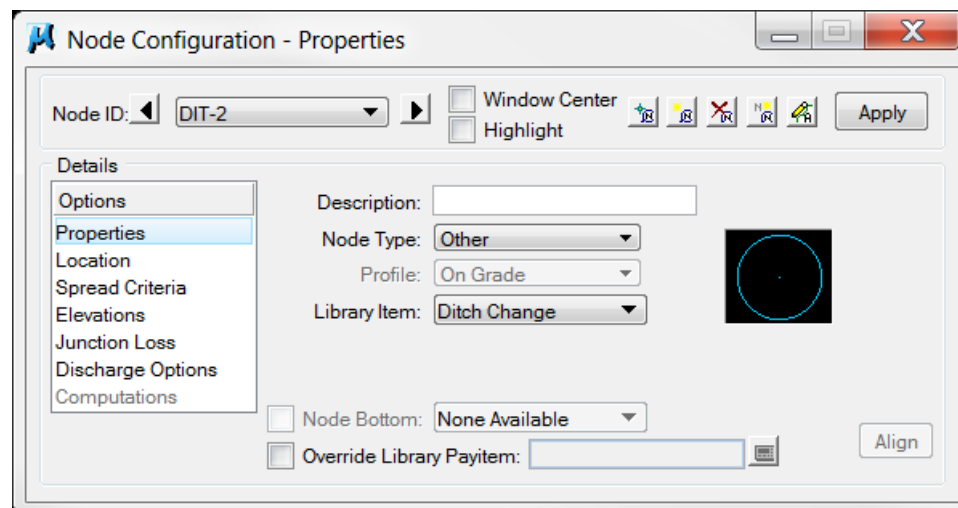
In this initial set up we are analyzing the flow along the fill slope and will set them as shown.



**Step 2.** Select from the Drainage Menu Bar: **Component > Node > Add** or from the main toolbar: **Add Drainage Node**.

**Step 3.** In the **New Node** window that appears, set the name **DIT-2** and click **OK**.

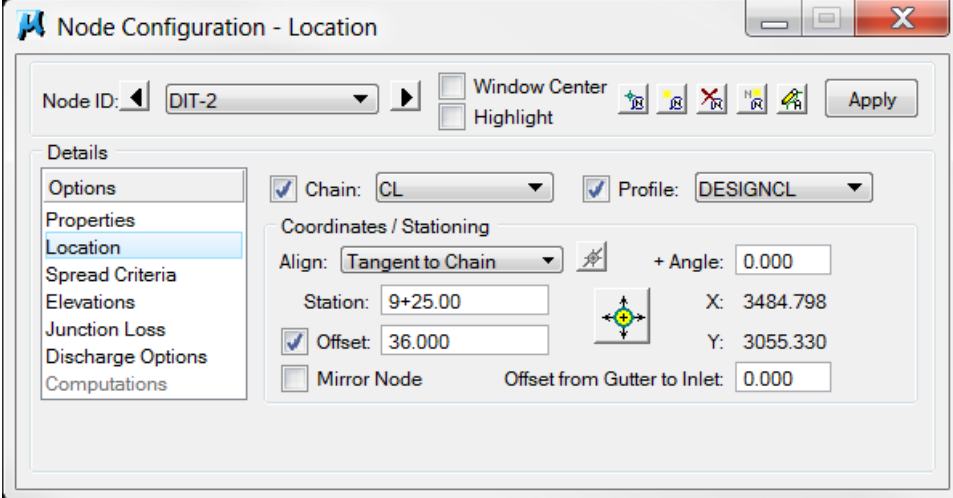
**Step 4.** **Properties >** Set **Node Type** to Other and **Library Item** to Ditch Change.



**Step 5. Location** > All settings should have carried over from DIT-1. Review and make the following changes (estimated change locations):

**Station:** 9+25.00

**Offset:** 36.00



The image shows the 'Node Configuration - Location' dialog box in GEOPAK Drainage. The 'Node ID' is set to 'DIT-2'. The 'Chain' is set to 'CL' and the 'Profile' is set to 'DESIGNCL'. The 'Coordinates / Stationing' section shows 'Align' set to 'Tangent to Chain', 'Station' set to '9+25.00', 'Offset' set to '36.00', and 'Mirror Node' unchecked. The 'X' coordinate is 3484.798 and the 'Y' coordinate is 3055.330. The 'Offset from Gutter to Inlet' is set to '0.000'. The 'Details' list on the left includes Options, Properties, Location (selected), Spread Criteria, Elevations, Junction Loss, Discharge Options, and Computations. The 'Window Center' and 'Highlight' checkboxes are unchecked. The 'Apply' button is visible.

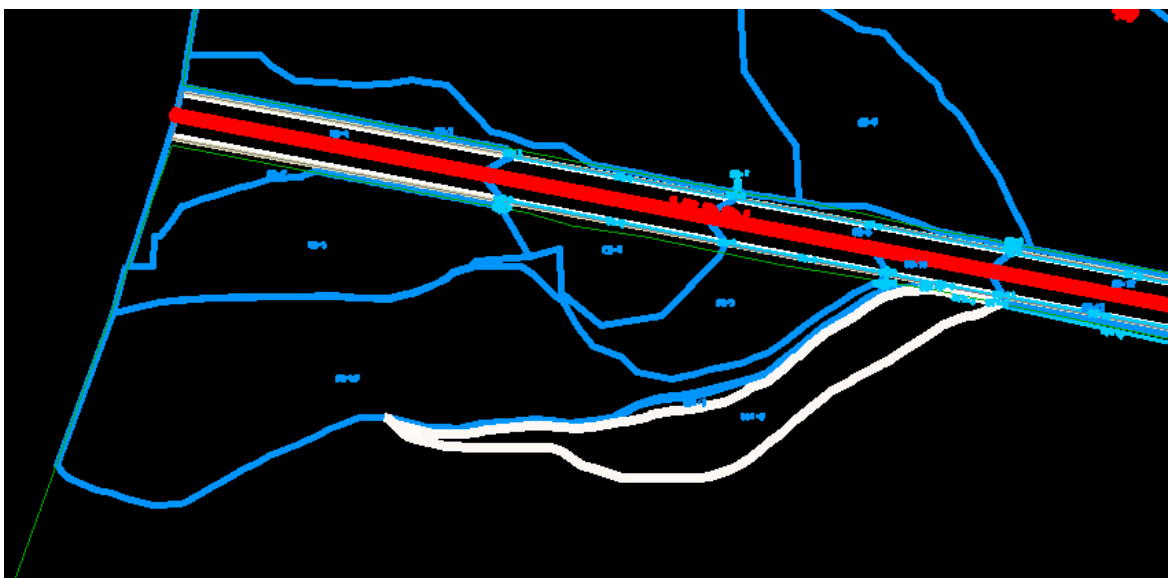
**Step 6.** Click **Apply**.

### Ditch Change Drainage Area

**Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **DIT-2** should automatically appear, click **OK**.

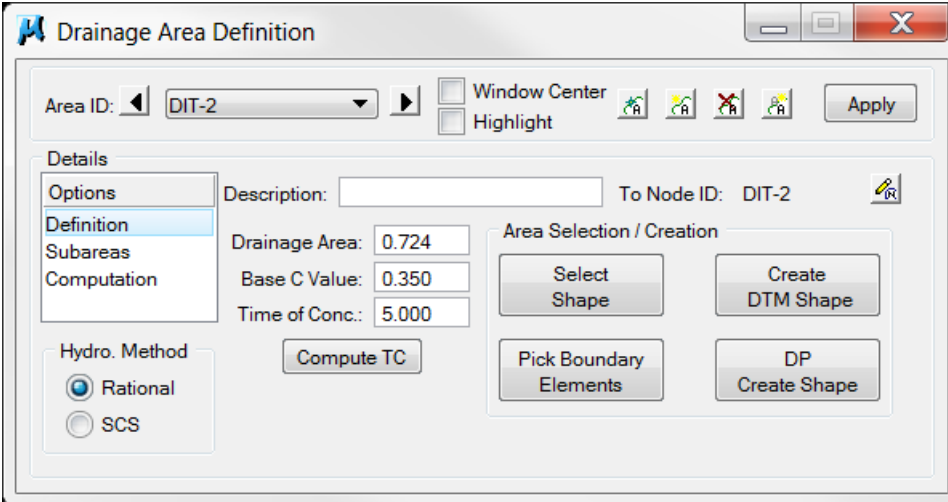
**Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for this ditch change location.

Delineate Drainage Area:



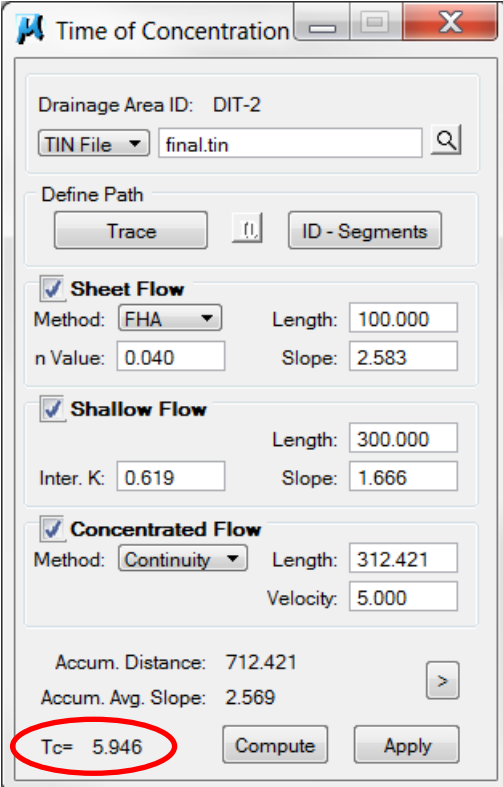
## Exercise 7

Define Drainage Area:



The "Drainage Area Definition" dialog box is shown. It has a title bar with a blue 'M' icon and standard window controls. The "Area ID" is set to "DIT-2". There are checkboxes for "Window Center" and "Highlight", and an "Apply" button. A "Details" section on the left has a tree view with "Options", "Definition" (selected), "Subareas", and "Computation". The "Description" field is empty, and "To Node ID" is "DIT-2". The "Drainage Area" is 0.724, "Base C Value" is 0.350, and "Time of Conc." is 5.000. There is a "Compute TC" button. The "Hydro. Method" section has radio buttons for "Rational" (selected) and "SCS". The "Area Selection / Creation" section has buttons for "Select Shape", "Create DTM Shape", "Pick Boundary Elements", and "DP Create Shape".

Calculate Time of Concentration:

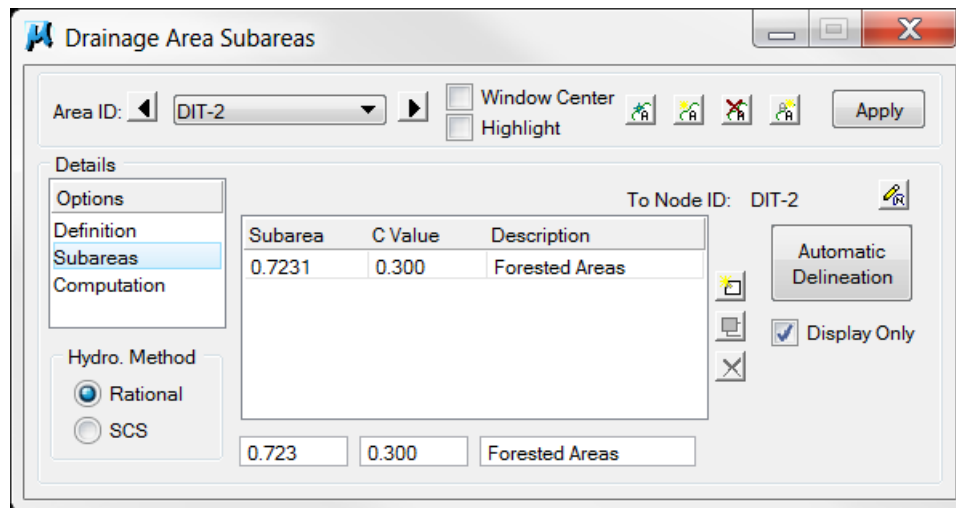


The "Time of Concentration" dialog box is shown. It has a title bar with a blue 'M' icon and standard window controls. The "Drainage Area ID" is "DIT-2". The "TIN File" is "final.tin". The "Define Path" section has a "Trace" button and an "ID - Segments" button. The "Sheet Flow" section is checked, with "Method" set to "FHA", "Length" 100.000, and "n Value" 0.040. The "Slope" is 2.583. The "Shallow Flow" section is checked, with "Length" 300.000, "Inter. K" 0.619, and "Slope" 1.666. The "Concentrated Flow" section is checked, with "Method" set to "Continuity", "Length" 312.421, and "Velocity" 5.000. The "Accum. Distance" is 712.421 and "Accum. Avg. Slope" is 2.569. The "Tc" is 5.946, which is circled in red. There are "Compute" and "Apply" buttons.

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required



Delineate Subareas utilizing the Land Use DGN:

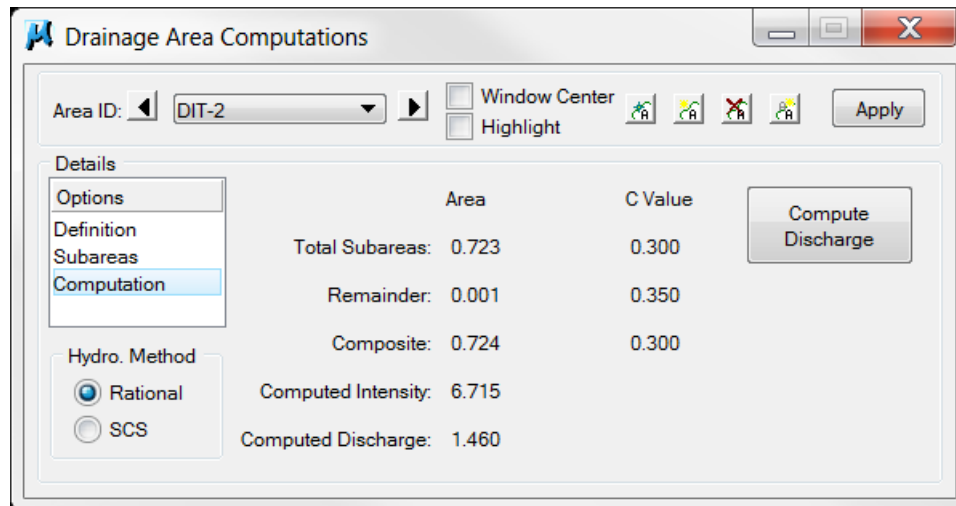


The **Drainage Area Subareas** dialog box is shown. The **Area ID** is set to **DIT-2**. The **Details** tab is selected, showing a table of subareas. The **Hydro. Method** is set to **Rational**. The **Automatic Delineation** button is visible.

Subarea	C Value	Description
0.7231	0.300	Forested Areas

Below the table, the values **0.723** and **0.300** are entered, with the description **Forested Areas**.

Compute Discharge and Apply:



The **Drainage Area Computations** dialog box is shown. The **Area ID** is set to **DIT-2**. The **Details** tab is selected, showing a table of computations. The **Hydro. Method** is set to **Rational**. The **Compute Discharge** button is visible.

	Area	C Value
Total Subareas:	0.723	0.300
Remainder:	0.001	0.350
Composite:	0.724	0.300
Computed Intensity:	6.715	
Computed Discharge:	1.460	

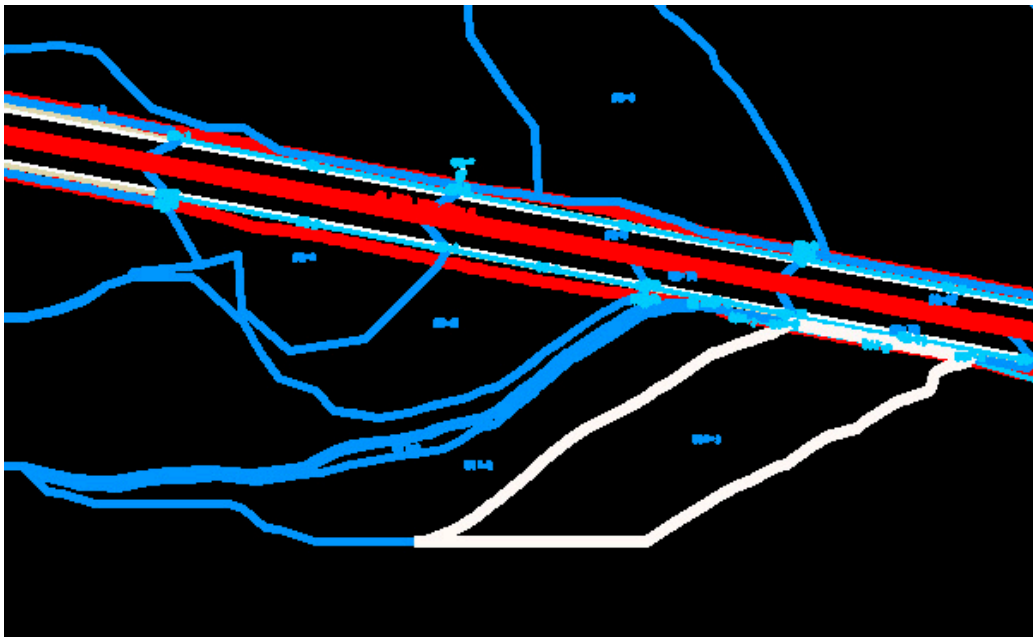
## Ditch Change #2

Repeat previous steps on pages 7-7 & 7-8 creating ditch change Node **DIT-3** at **Station: 10+90.00** and **Offset: 34.00**. All other information should remain unchanged.

## Ditch Change #2 Drainage Area

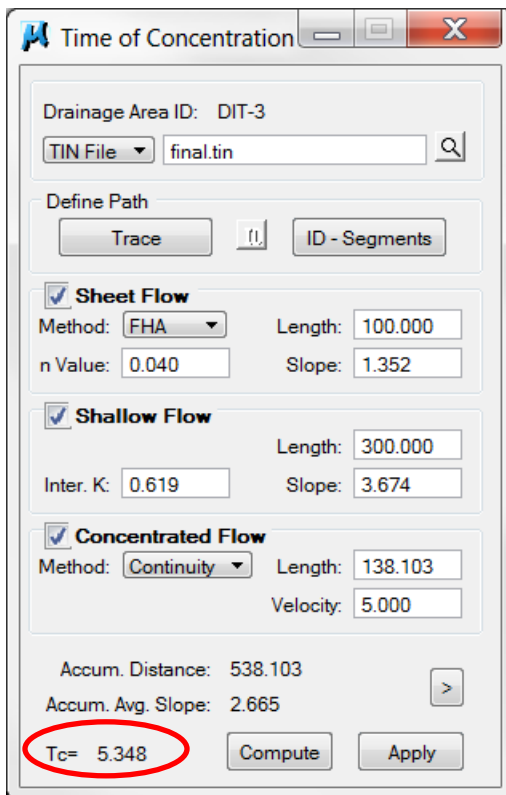
- Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **DIT-3** should automatically appear, click **OK**.
- Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for this ditch change location.

Delineate Drainage Area:



Define Drainage Area:

Calculate Time of Concentration:

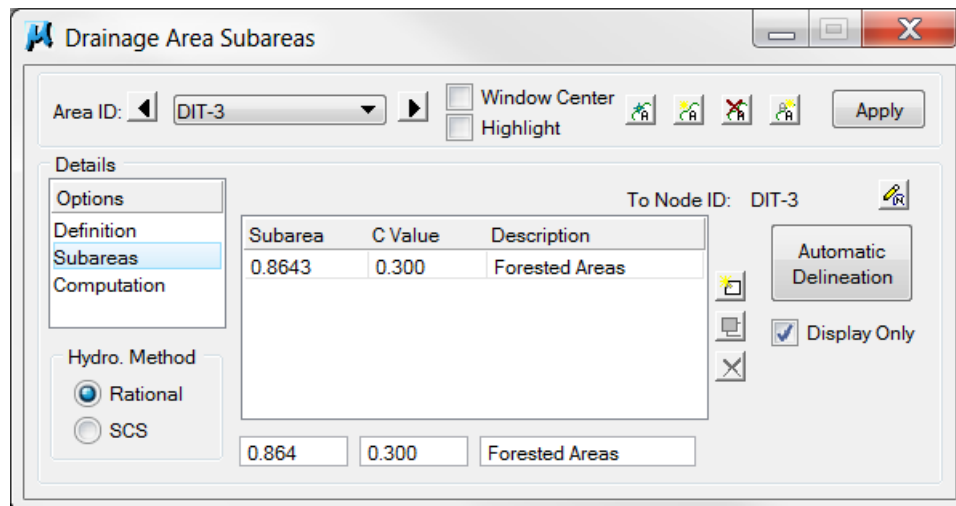


The dialog box is titled "Time of Concentration". It contains the following fields and controls:

- Drainage Area ID: DIT-3
- TIN File: final.tin
- Define Path: Trace, ID - Segments
- ☒ Sheet Flow
  - Method: FHA
  - Length: 100.000
  - n Value: 0.040
  - Slope: 1.352
- ☒ Shallow Flow
  - Length: 300.000
  - Inter. K: 0.619
  - Slope: 3.674
- ☒ Concentrated Flow
  - Method: Continuity
  - Length: 138.103
  - Velocity: 5.000
- Accum. Distance: 538.103
- Accum. Avg. Slope: 2.665
- Tc= 5.348 (circled in red)
- Buttons: Compute, Apply

The calculated Time of Concentration is **GREATER** than the minimum of 5 minutes; therefore the Time of Concentration will automatically be filled in after hitting Apply with NO further steps required

Delineate Subareas utilizing the Land Use DGN:



The dialog box is titled "Drainage Area Subareas". It contains the following fields and controls:

- Area ID: DIT-3
- Window Center, Highlight (checkboxes)
- Apply button
- Details
  - Options
  - Definition
  - Subareas (selected)
  - Computation
- Hydro. Method
  - ☒ Rational
  - ☐ SCS
- To Node ID: DIT-3
- Automatic Delineation button
- Display Only checkbox
- Table:

Subarea	C Value	Description
0.8643	0.300	Forested Areas
- Bottom summary row: 0.864, 0.300, Forested Areas

## Exercise 7

Compute Discharge and Apply:

Drainage Area Computations

Area ID:  ☐ Window Center ☐ Highlight

Details

Options

Definition

Subareas

Computation

	Area	C Value
Total Subareas:	0.864	0.300
Remainder:	0.011	0.350
Composite:	0.875	0.301

Hydro. Method

☒ Rational

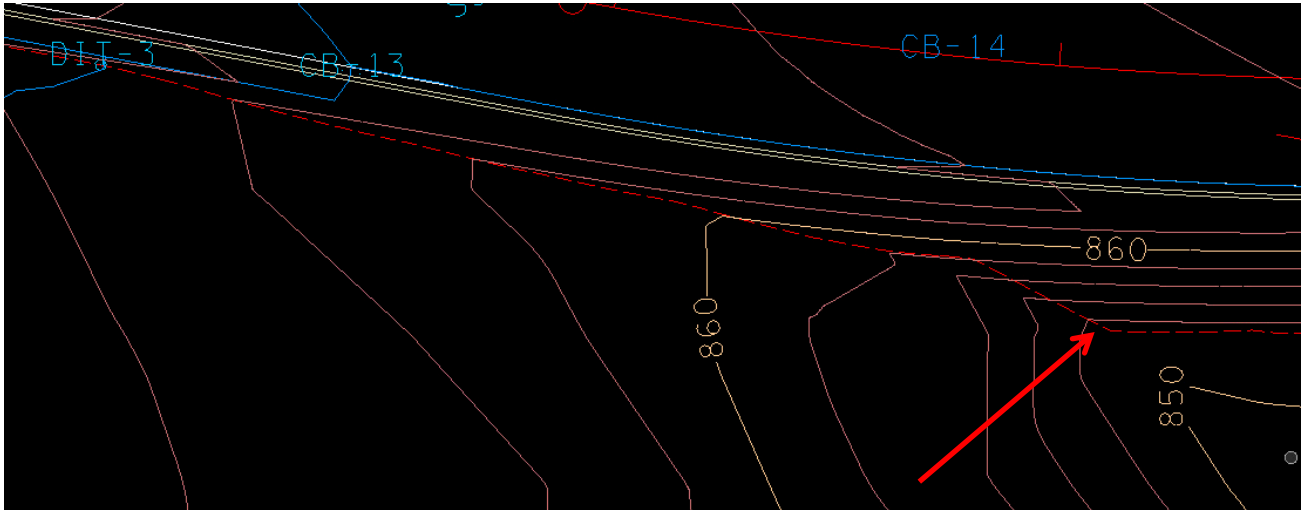
☐ SCS

Computed Intensity: 6.882

Computed Discharge: 1.810

## Ditch Outlet

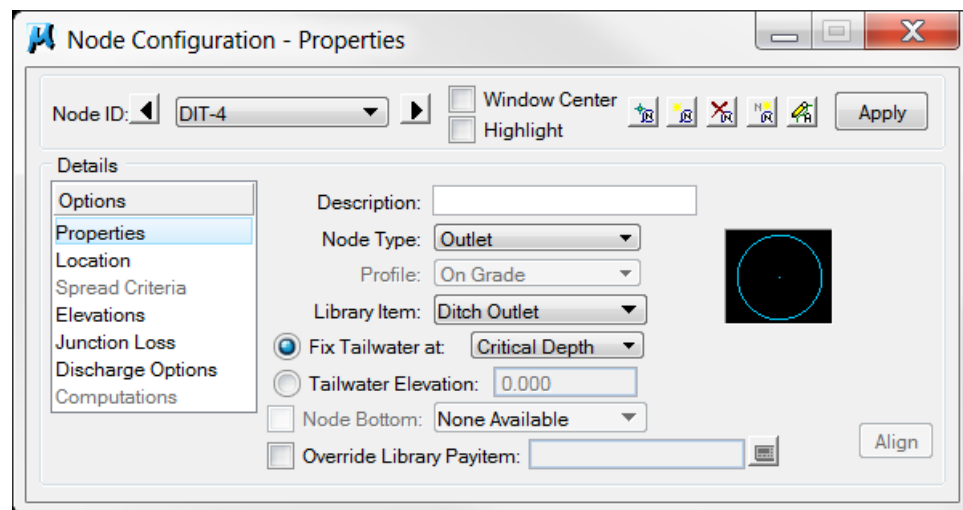
**Step 1.** Visually determine the location of the ditch outlet.



**Step 2.** Select from the Drainage Menu Bar: **Component > Node > Add** or from the main toolbar: **Add Drainage Node**.

**Step 3.** In the **New Node** window that appears, set the name **DIT-4** and click **OK**.

**Step 4.** **Properties >** Set **Node Type** to Outlet, **Library Item** to Ditch Outlet and **Fix Tailwater at Critical Depth**



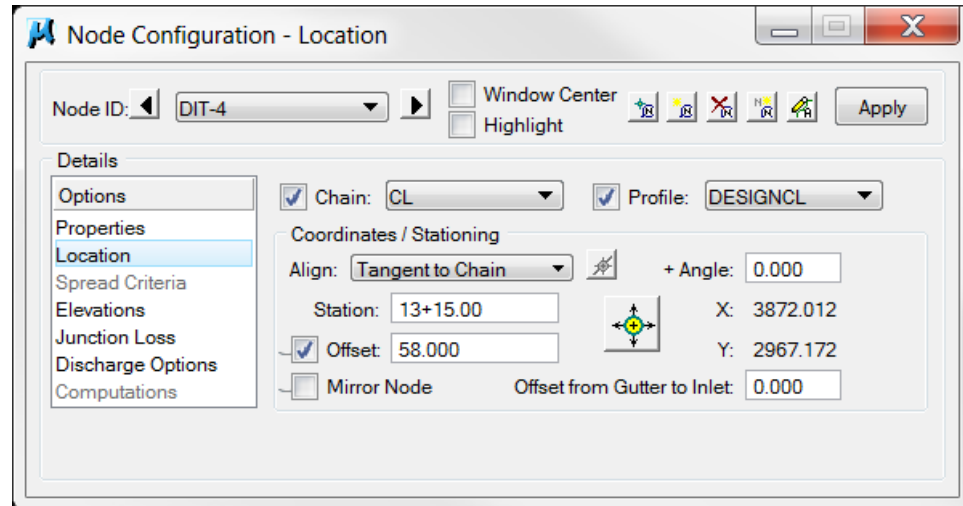


## Exercise 7

**Step 5. Location** > All settings should have carried over from DIT-3. Review and make the following changes:

**Station:** 13+15.00

**Offset:** 58.00



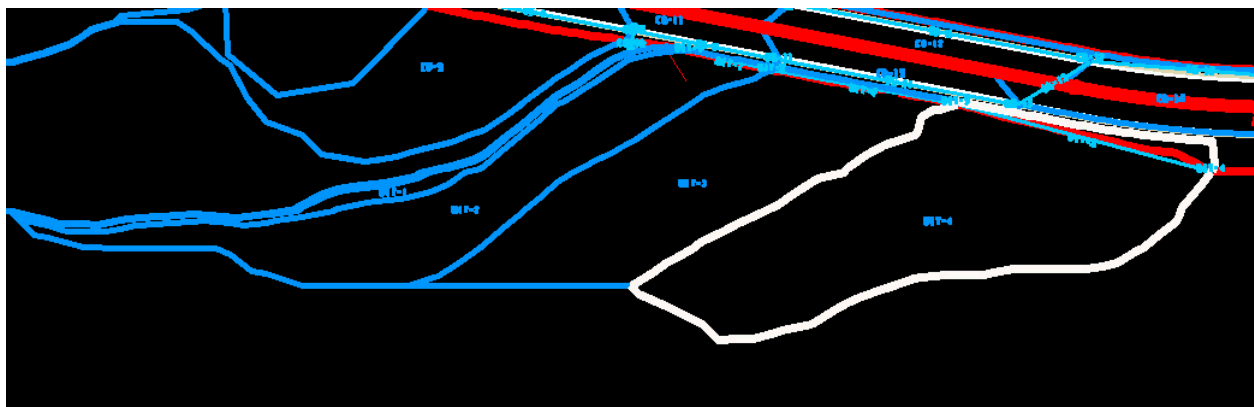
**Step 6.** All other options should be set from previous nodes, click **Apply**.

### Ditch Outlet Drainage Area

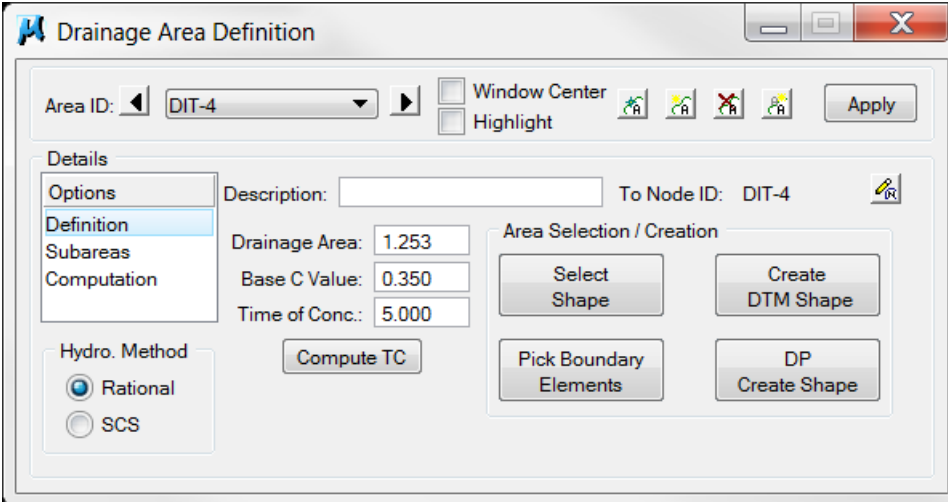
**Step 1.** From the Node Configuration dialog select **Edit Area**. When asked if you want to create a new drainage area click **Yes**. The name **DIT-4** should automatically appear, click **OK**.

**Step 2.** Follow the steps in Exercise 4.1 to delineate and define the drainage area for this ditch outlet location.

Delineate Drainage Area:

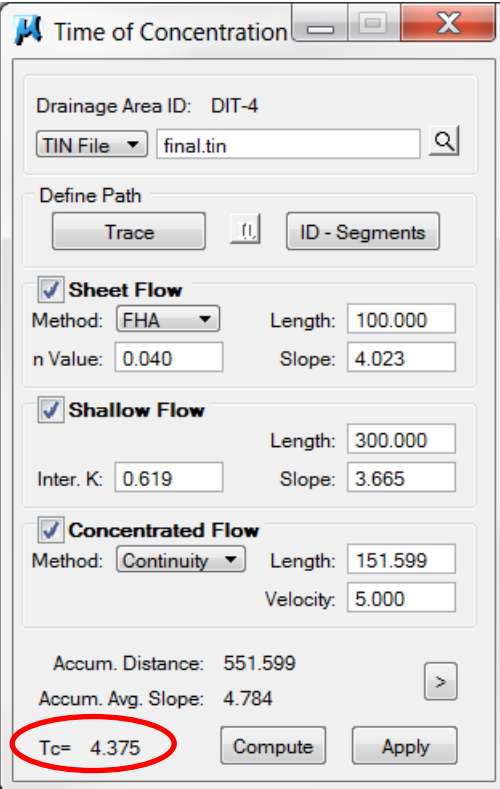


Define Drainage Area:



The 'Drainage Area Definition' dialog box is shown. It has a title bar with a blue icon, a minus button, a maximize button, and a close button. The 'Area ID' is set to 'DIT-4'. There are checkboxes for 'Window Center' and 'Highlight'. An 'Apply' button is on the right. The 'Details' section has a left sidebar with 'Options', 'Definition' (selected), 'Subareas', and 'Computation'. The 'Description' field is empty. 'To Node ID' is 'DIT-4'. 'Drainage Area' is 1.253, 'Base C Value' is 0.350, and 'Time of Conc.' is 5.000. There is a 'Compute TC' button. The 'Hydro. Method' section has radio buttons for 'Rational' (selected) and 'SCS'. The 'Area Selection / Creation' section has buttons for 'Select Shape', 'Create DTM Shape', 'Pick Boundary Elements', and 'DP Create Shape'.

Calculate Time of Concentration:

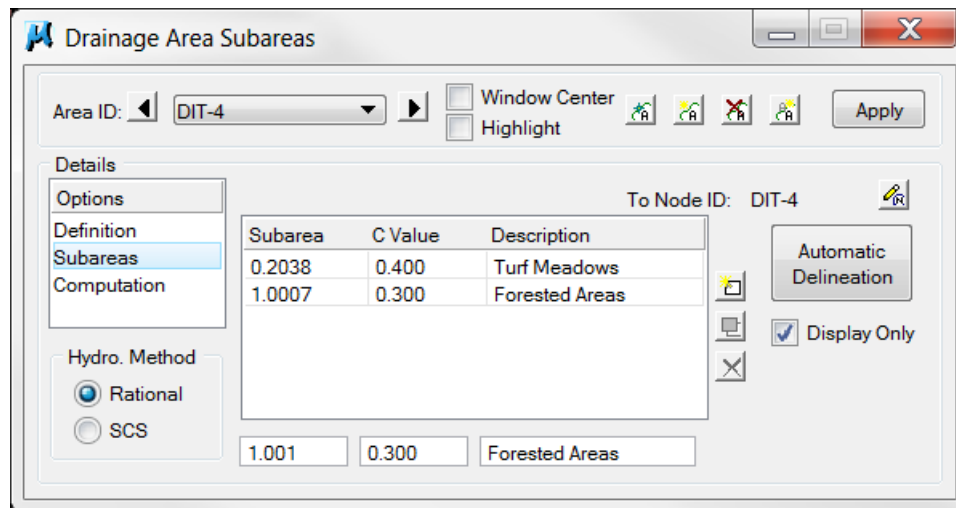


The 'Time of Concentration' dialog box is shown. It has a title bar with a blue icon, a minus button, a maximize button, and a close button. The 'Drainage Area ID' is 'DIT-4'. The 'TIN File' is 'final.tin'. The 'Define Path' section has 'Trace' and 'ID - Segments' buttons. There are three checked sections: 'Sheet Flow' with 'Method: FHA', 'Length: 100.000', and 'n Value: 0.040'; 'Shallow Flow' with 'Length: 300.000' and 'Inter. K: 0.619'; and 'Concentrated Flow' with 'Method: Continuity', 'Length: 151.599', and 'Velocity: 5.000'. At the bottom, 'Accum. Distance' is 551.599 and 'Accum. Avg. Slope' is 4.784. The 'Tc' is 4.375, which is circled in red. There are 'Compute' and 'Apply' buttons.

The calculated Time of Concentration is less than the minimum of 5 minutes, therefore **5 must be manually typed** in the Drainage Area Definition dialog after hitting apply in the Time of Concentration Window.

## Exercise 7

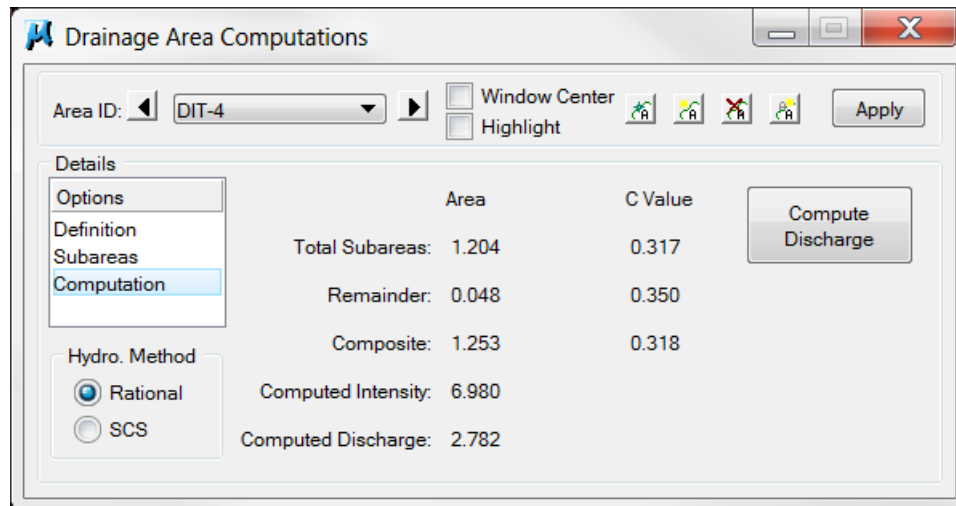
Delineate Subareas utilizing the Land Use DGN:



The 'Drainage Area Subareas' dialog box is shown. It features a window title bar with standard controls. Below the title bar, there is a section for 'Area ID' with a dropdown menu set to 'DIT-4' and buttons for 'Window Center' and 'Highlight'. To the right of these are four small icons and an 'Apply' button. A 'Details' section on the left contains a list box with 'Options', 'Definition', 'Subareas' (selected), and 'Computation'. Below this is a 'Hydro. Method' section with radio buttons for 'Rational' (selected) and 'SCS'. The main area contains a table with columns 'Subarea', 'C Value', and 'Description'. The table has two rows: '0.2038 0.400 Turf Meadows' and '1.0007 0.300 Forested Areas'. To the right of the table is a 'To Node ID' field set to 'DIT-4' and a 'Compute' button. Below the table are input fields for '1.001', '0.300', and 'Forested Areas'. On the far right, there are buttons for 'Automatic Delineation' and 'Display Only' (checked).

Subarea	C Value	Description
0.2038	0.400	Turf Meadows
1.0007	0.300	Forested Areas

Compute Discharge and Apply:

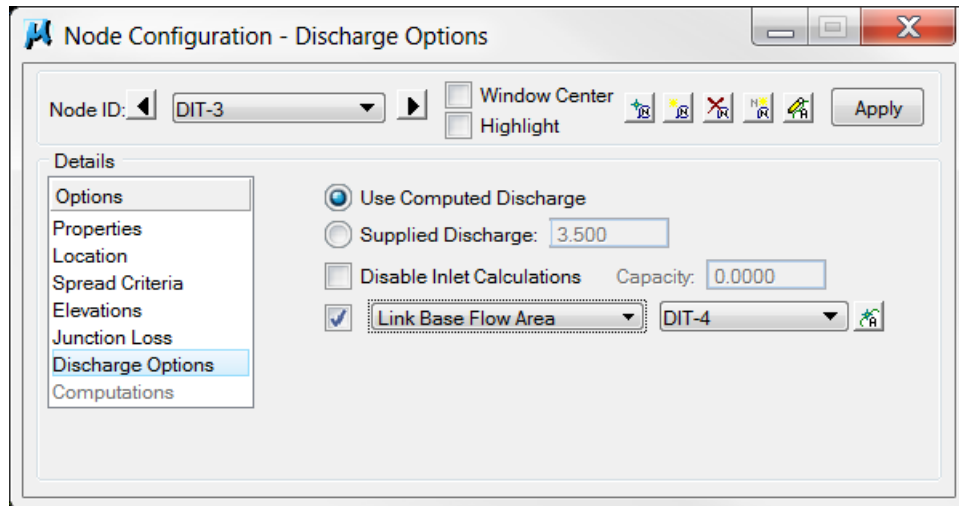


The 'Drainage Area Computations' dialog box is shown. It has a similar layout to the previous dialog. The 'Area ID' is 'DIT-4'. The 'Details' list box has 'Options', 'Definition', 'Subareas', and 'Computation' (selected). The 'Hydro. Method' section has 'Rational' (selected) and 'SCS'. The main area displays a table with columns 'Area' and 'C Value'. The table has three rows: 'Total Subareas: 1.204 0.317', 'Remainder: 0.048 0.350', and 'Composite: 1.253 0.318'. Below the table, it shows 'Computed Intensity: 6.980' and 'Computed Discharge: 2.782'. A 'Compute Discharge' button is located to the right of the table. The 'Window Center' and 'Highlight' buttons are present, along with the same four small icons and an 'Apply' button.

Area	C Value
Total Subareas: 1.204	0.317
Remainder: 0.048	0.350
Composite: 1.253	0.318

**Step 3.** Since Node DIT-4 is an outlet type, it will **not** consider the drainage area developed for it. In order to ensure the final ditch link, will be adequate for the capacity at the end we will need to link the DIT-4 drainage area to Node DIT-3.

Go to **Component> Node> Edit** and select node DIT-3. Under Discharge Options click on the option to **Link Base Flow Area** and set to include the DIT-4 drainage area.



## 7.2 Link Design

We are checking the drainage flow along a fill slope so all links are set up as cross section based. The surface is read for the ditch shape and capacity at each cross section that is dropped along the links.

### Cross Section Based Link DIT-1

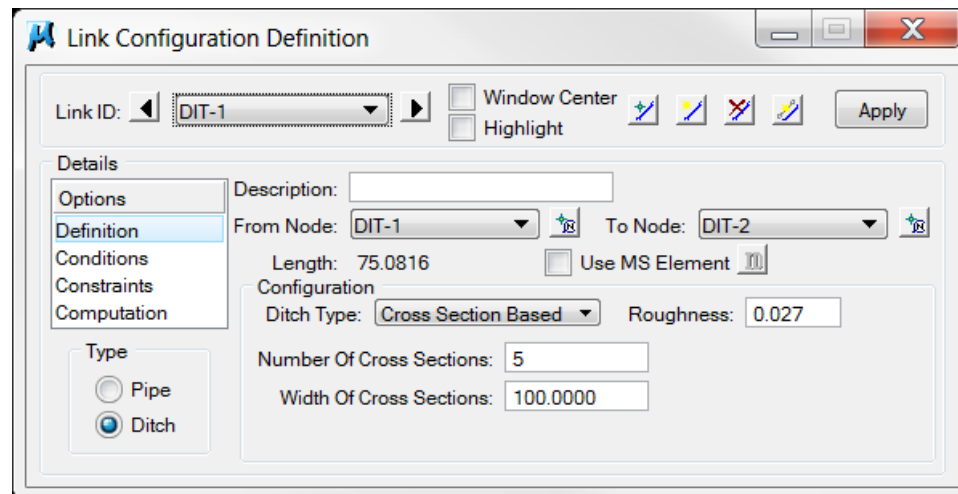
- Step 1.** Select from the Drainage Menu Bar: **Component > Link > Add** or from the main toolbar: **Add Drainage Link**
- Step 2.** Set the Name to **DIT-1** and click **OK**.
- Step 3.** Set the **From Node** as **DIT-1** and the **To Node** as **DIT-2** via the dropdown list or by clicking the **Node ID** button and selecting the appropriate node.
- Step 4.** In the *Details* portion of the dialog change **Type** to **Ditch**.
- Step 5.** In the *Configuration* portion of the dialog set the following:

**Ditch Type:** Cross Section Based

**Roughness:** 0.027 (See [TDOT Drainage Manual Chapter 5](#) Table 5A-1 for typical values)

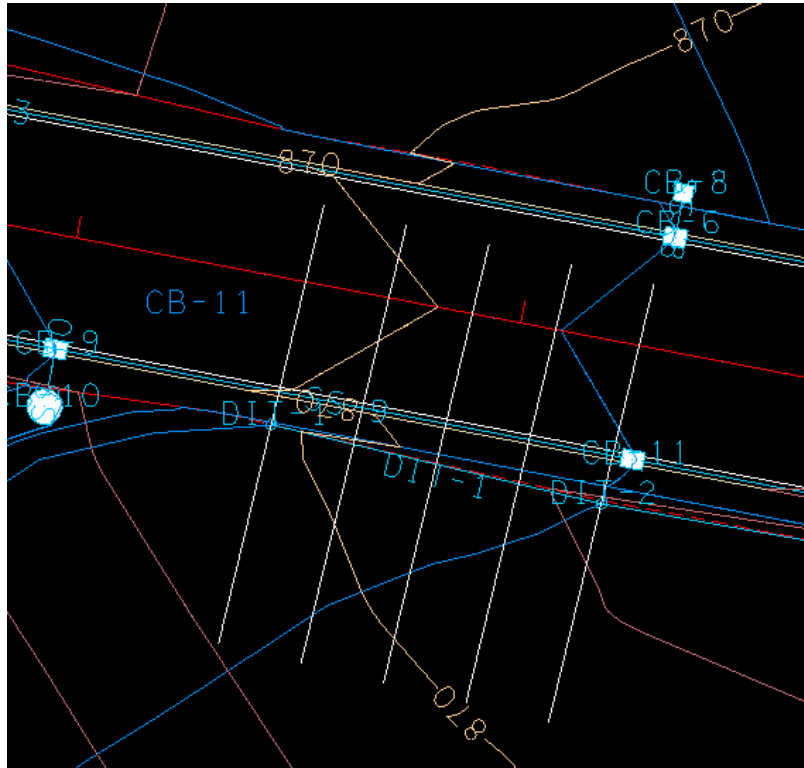
**Number of Cross Sections:** 5 (Typically one cross section every 5 feet to a maximum of every 50 feet for long ditches)

**Width of Cross Sections:** 100 (Ensure top of bank on both sides is captured)





**Step 6.** Click **Apply** and review the cross section lines displayed in the plan view (shown on next page) to determine if adjustments should be made.



**NOTES:**

Since we are using the Cross Section Based ditch type to analyze existing conditions, the **Conditions** and **Constraints** require no special settings. In the system modification chapter, we will use those to control the proposed ditch that is to be designed.

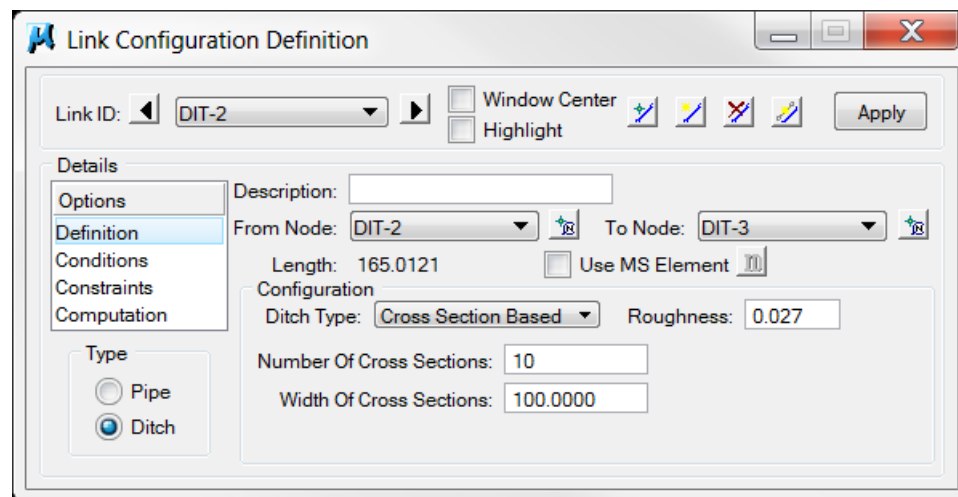
**Computation** will not show any information until a drainage network is built from the nodes and links in this ditch system.

This same set up using the **Cross Section Based** ditch type can be used to analyze long proposed roadway ditches for capacity and function.

## Exercise 7

### Cross Section Based Link DIT-2

- Step 1.** Select from the Drainage Menu Bar: **Component > Link > Add** or from the main toolbar: **Add Drainage Link**
- Step 2.** Set the Name to **DIT-2** and click **OK**.
- Step 3.** Set the **From Node** as **DIT-2** and the **To Node** as **DIT-3** via the dropdown list or by clicking the **Node ID** button and selecting the appropriate node.
- Step 4.** In the *Details* portion of the dialog change **Type** to **Ditch**.
- Step 5.** In the *Configuration* portion of the dialog set the following:
- Ditch Type:** Cross Section Based
- Roughness:** 0.027 (See [TDOT Drainage Manual Chapter 5](#) Table 5A-1 for typical values)
- Number of Cross Sections:** 10 (Typically one cross section every 5 feet to a maximum of every 50 feet for long ditches)
- Width of Cross Sections:** 100 (Ensure top of bank on both sides is captured)

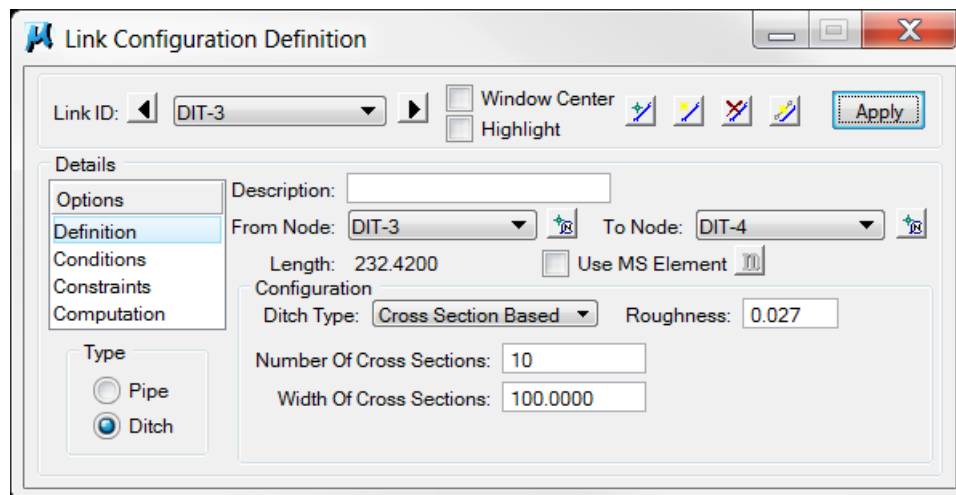


- Step 6.** Click **Apply**.

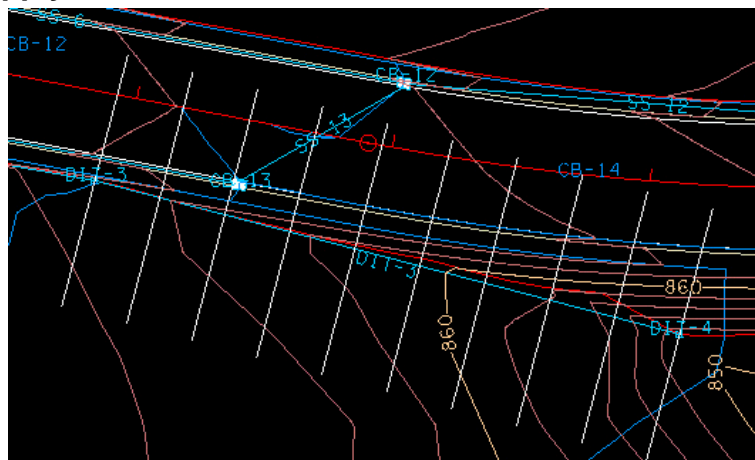


### Cross Section Based Link DIT-3

- Step 1.** Select from the Drainage Menu Bar: **Component > Link > Add** or from the main toolbar: **Add Drainage Link**
- Step 2.** Set the Name to **DIT-3** and click **OK**.
- Step 3.** Set the **From Node** as **DIT-3** and the **To Node** as **DIT-4** via the dropdown list or by clicking the **Node ID** button and selecting the appropriate node.
- Step 4.** In the *Details* portion of the dialog change **Type** to **Ditch**.
- Step 5.** In the *Configuration* portion of the dialog set the following:
- Ditch Type:** Cross Section Based
- Roughness:** 0.027 (See [TDOT Drainage Manual Chapter 5](#) Table 5A-1 for typical values)
- Number of Cross Sections:** 10 (Typically one cross section every 5 feet to a maximum of every 50 feet for long ditches)
- Width of Cross Sections:** 100 (Ensure top of bank on both sides is captured)



- Step 6.** Click **Apply**.



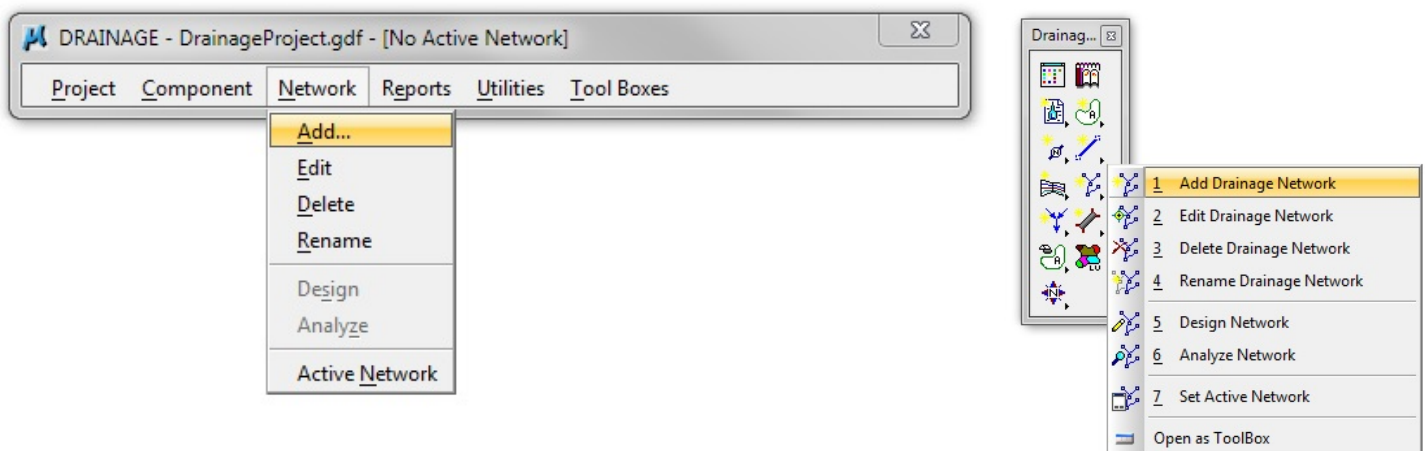
# Drainage Networks

This exercise shows the user how to setup a network and perform network computations.

The Network computations serve as the final calculation process in the design or analysis of a storm drainage system. A GEOPAK drainage network is defined as a series of interconnected nodes, links and areas which drain to a single outlet. GEOPAK drainage accommodates multiple networks in a single drainage project.

## 8.1 Storm Drainage Network Design

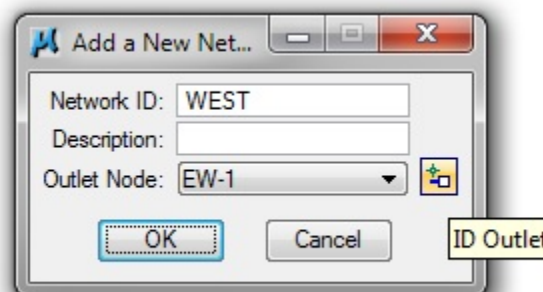
**Step 1.** Select the **Add Drainage Network** tool or select **Network > Add** from the main drainage menu bar.



**Step 2.** In the **Add a New Network** dialog, enter the following information:

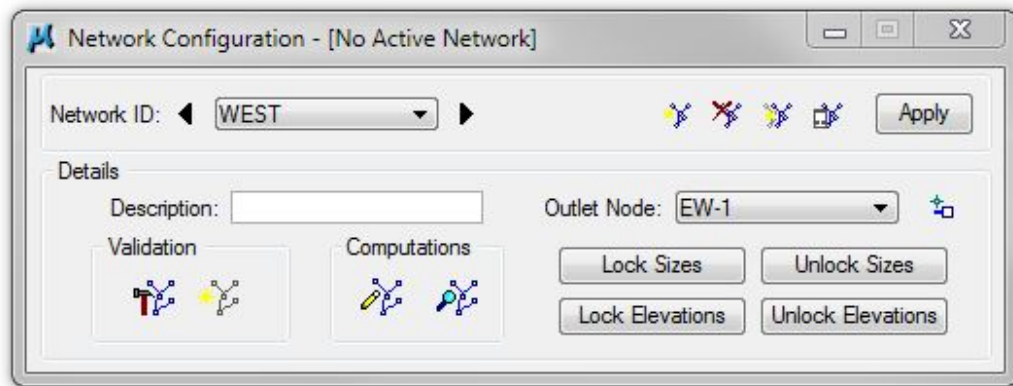
**Network ID:** WEST

**Outlet Node:** EW-1

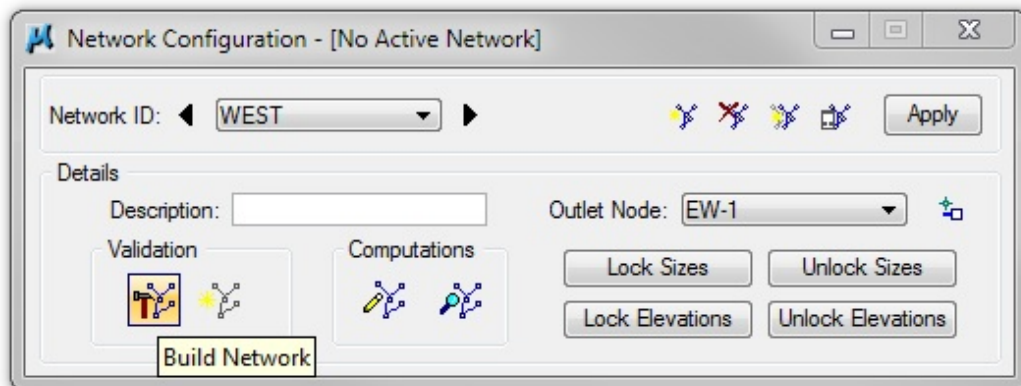


**NOTE:** The **Outlet Node** may be selected via the dropdown or by clicking **ID Outlet** and selecting the Node in the plan view.

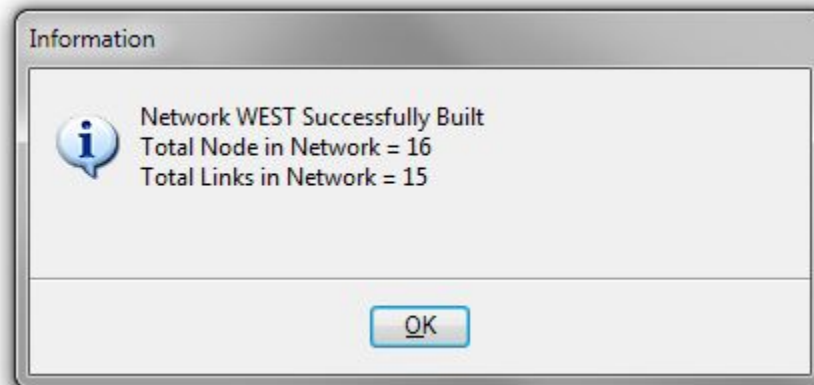
**Step 3.** Click **OK** in the Add a New Network dialog box.



**Step 4.** Click the **Build Network** button. This feature verifies the nodes and link connectivity.



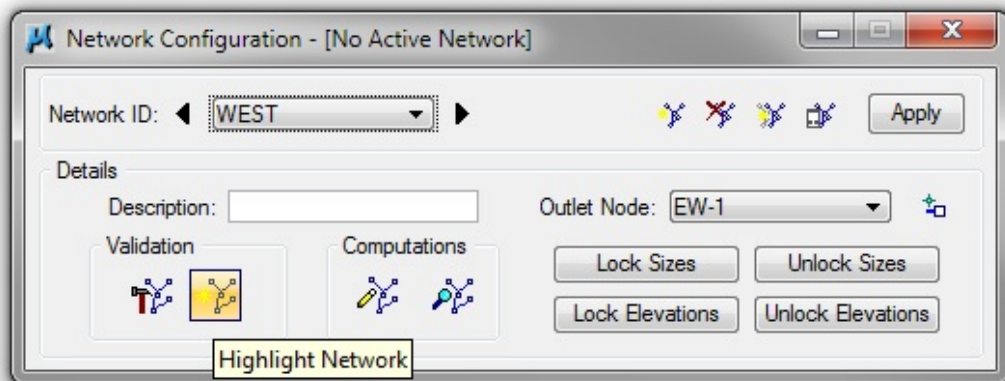
Click **OK**.



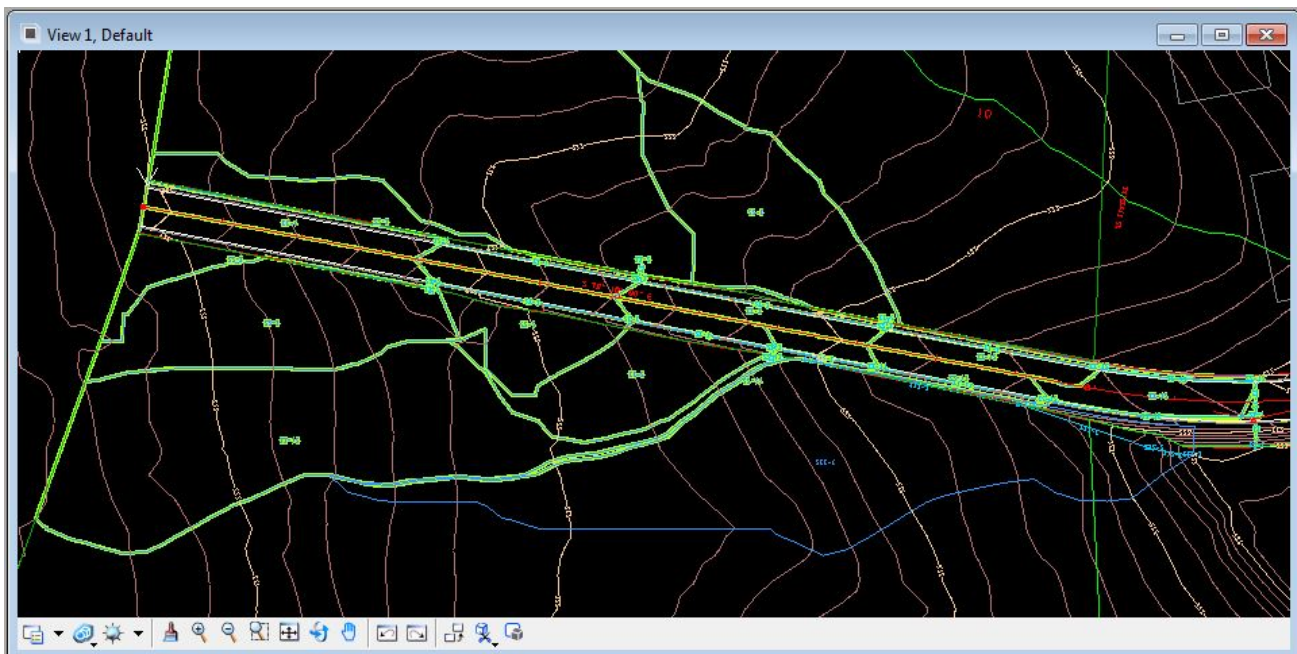


## Exercise 8

**Step 5.** Click the **Highlight Network** feature. This Feature highlights all components (areas, inlets, pipes, etc.) connected to the active Network.



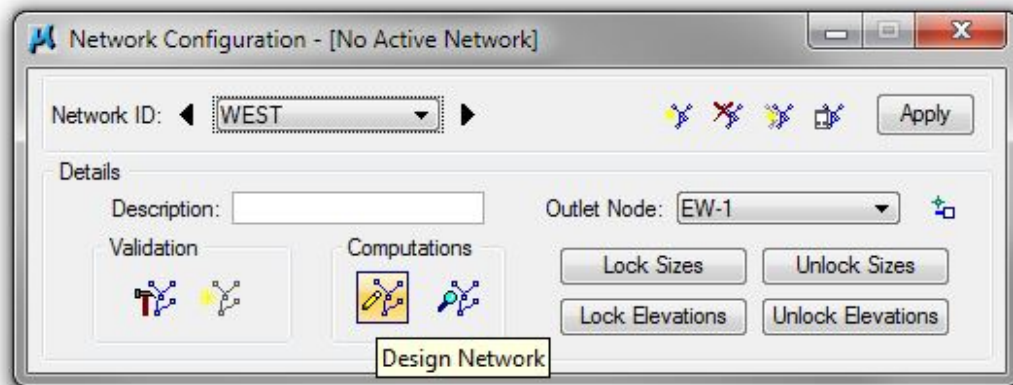
**Step 6.** Verify that all network components are highlighted.



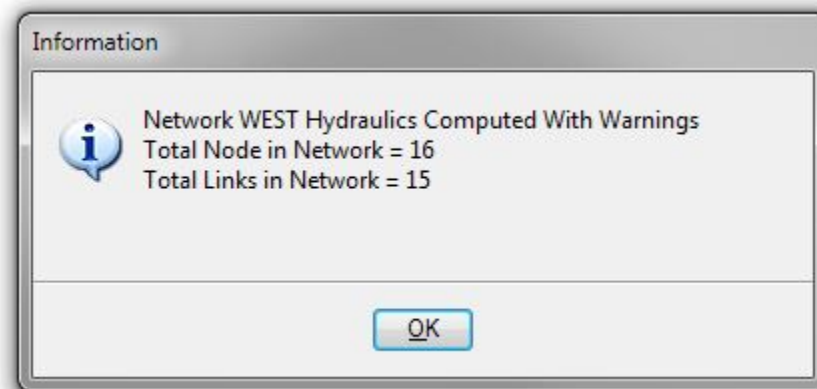
**NOTE:** The ditch Nodes and Links created in Exercise 7 are not highlighted since they do not connect with the storm drainage system.

**Step 7.** Click the **Apply** button. Network "WEST" has been added to the project.

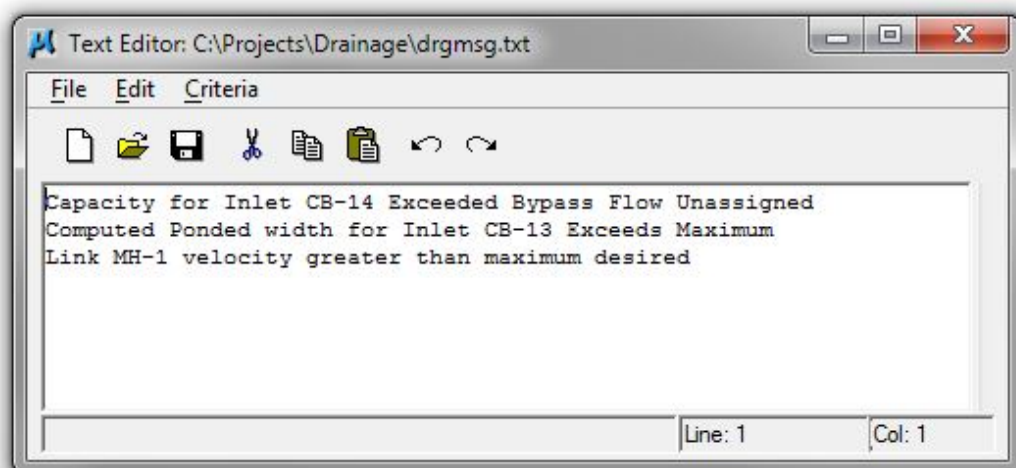
- Step 8.** Click the **Design** button. This command initiates the hydraulic design of the components contained in the Network.



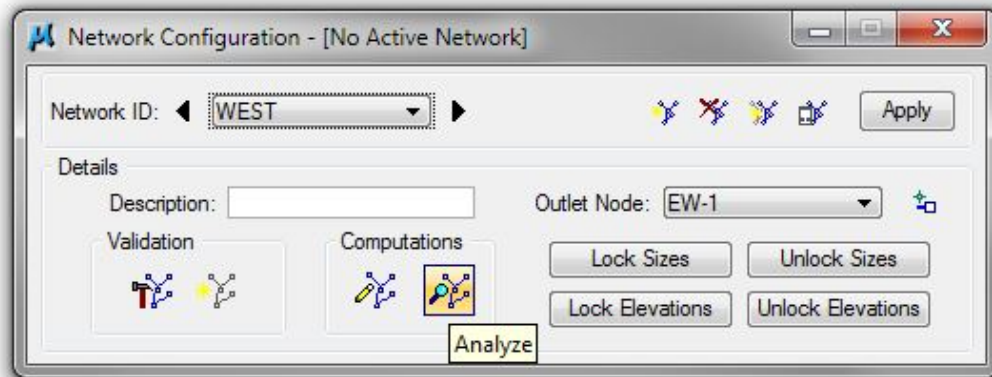
Click **OK**.



- Step 9.** Review errors to determine steps needed to correct and close the text editor. (See **Appendix C** for common errors and fixes)



## Exercise 8



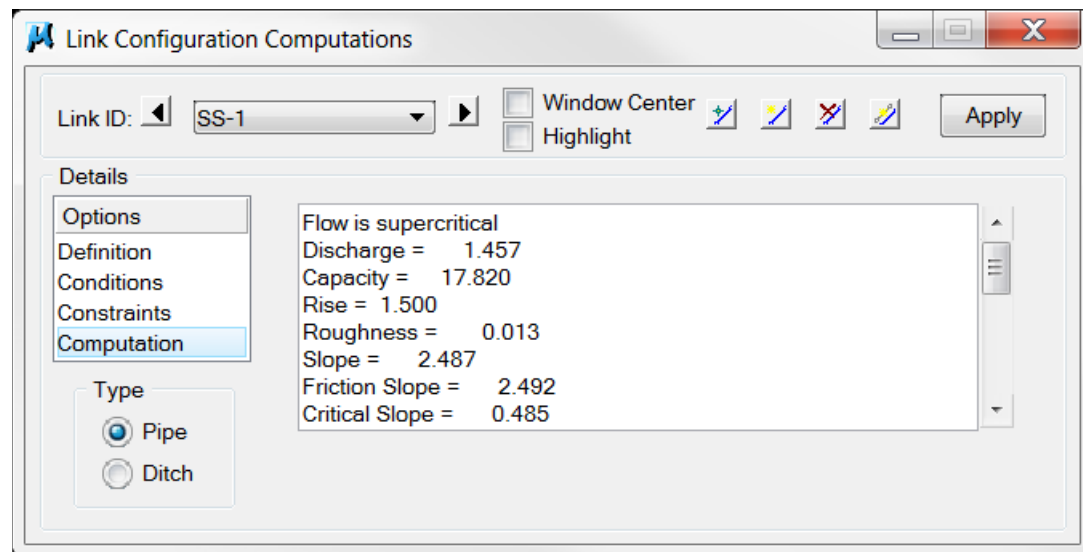
### NOTES:

Pressing Design or Analyze should be the last step in Designing or Analyzing the Network.

**Design** performs hydraulic design of the network and designs components of the network as indicated by the 'design toggles'. **Analyze** performs hydraulic analysis of the network as is and ignores all 'design toggles'.

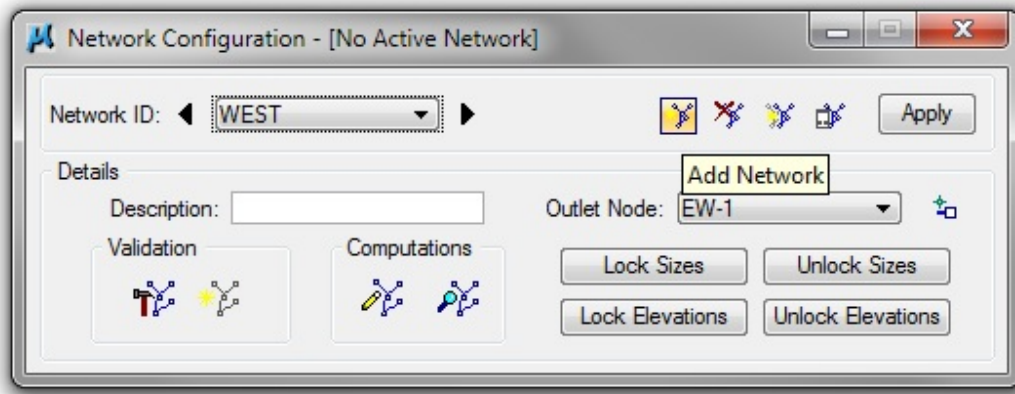
**Lock** and **Unlock buttons** allow the user to lock or unlock all components in a network at the given **Size** or **Elevation**. **Caution** must be used when selecting **Unlock** as this action will unlock ALL **Sizes** or **Elevations**, including ones that should not have been unlocked.

After **Design** or **Analyze** has been utilized, computation values are shown in each link configuration of the network which can be reviewed in the Link Configuration edit dialog. Other methods of reviewing this data will be discussed in Exercise 10, Drainage Navigator.



## 8.2 Ditch Network Design

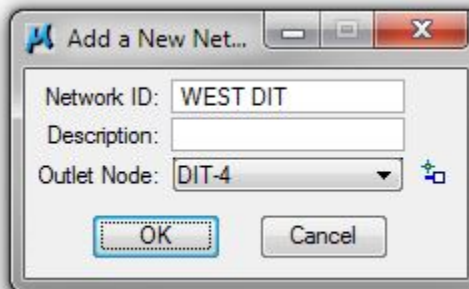
- Step 1.** Select the **Add Drainage Network** tool, select **Network > Add** from the main drainage menu bar or click the **Add Network** button in the Network Configuration Dialog.



- Step 2.** In the **Add a New Network** dialog, enter the following information:

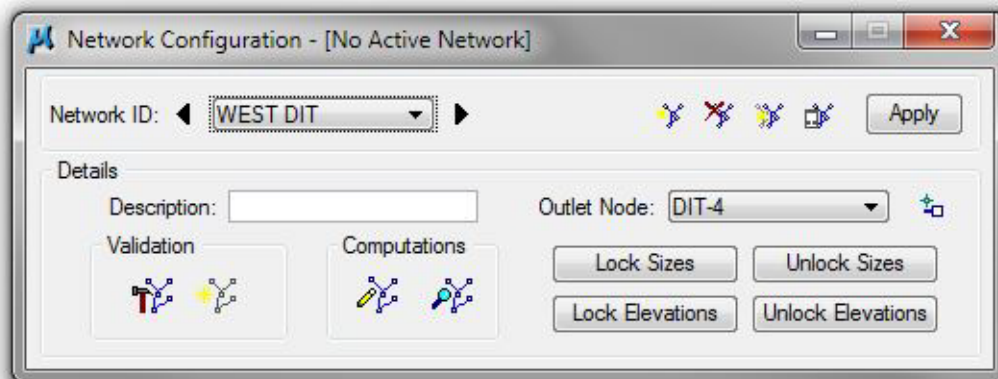
**Network ID:** WEST DIT

**Outlet Node:** DIT-4



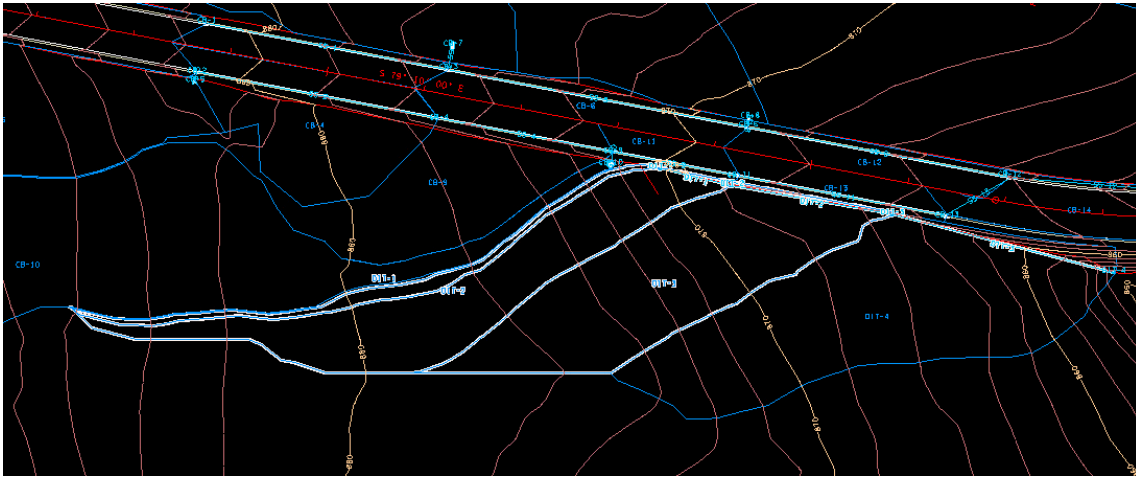
**NOTE:** The **Outlet Node** may be selected via the dropdown or by clicking **ID Outlet** and selecting the Node in the plan view.

- Step 3.** Click **OK** in the Add a New Network dialog box.



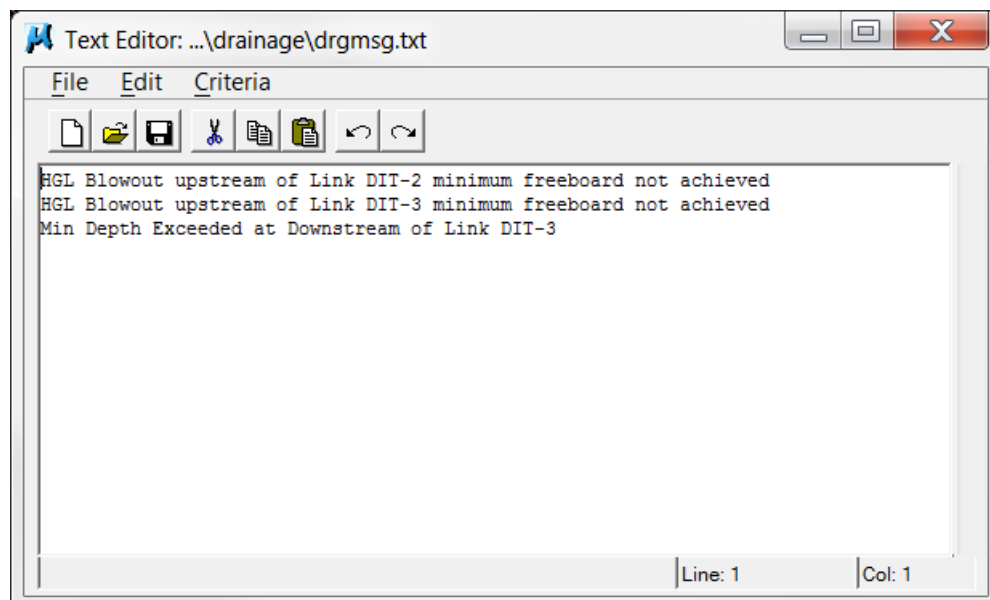
## Exercise 8

- Step 4.** Click the **Build Network** button. Click **OK**.
- Step 5.** Click the **Highlight Network** feature.
- Step 6.** Verify that all network components are highlighted.



**NOTE:** The drainage area DIT-4 will not be highlighted since it is built for an outlet node type which does not consider drainage areas. In the previous chapter, we linked that area to node DIT-3 so that it is covered in this ditch drainage analysis.

- Step 7.** Click the **Apply** button. Network “WEST DIT” has been added to the project.
- Step 8.** Click the **Design** button, then click **OK**.
- Step 9.** Review errors to determine steps needed to correct and close the text editor.  
(See **Appendix C** for common errors and fixes)



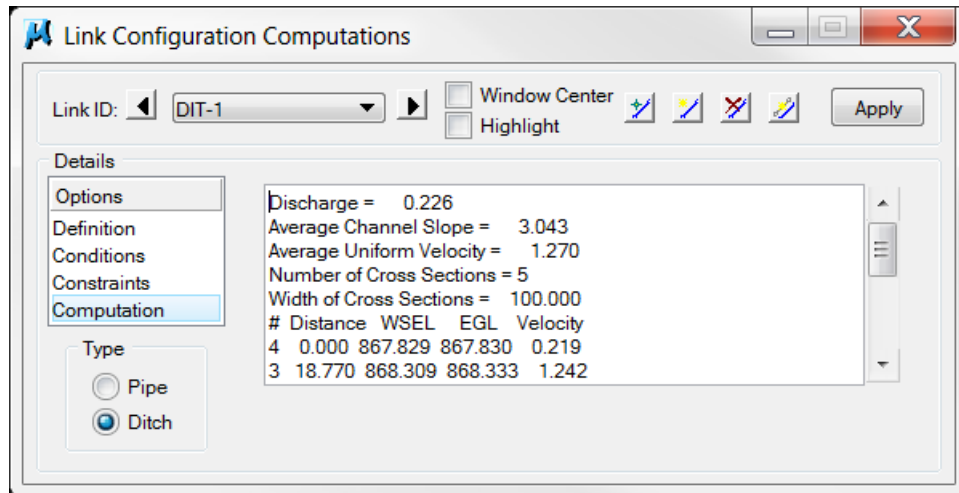


## Existing Ditch Link Review

Now that the ditch network has been built and designed, we can review the computation results for the existing ditch links in the network.

**Step 1.** Select the **Edit Link** tool, select **Component> Link> Edit** from the main drainage menu bar or click the **Edit Link** button in the Network Configuration Dialog.

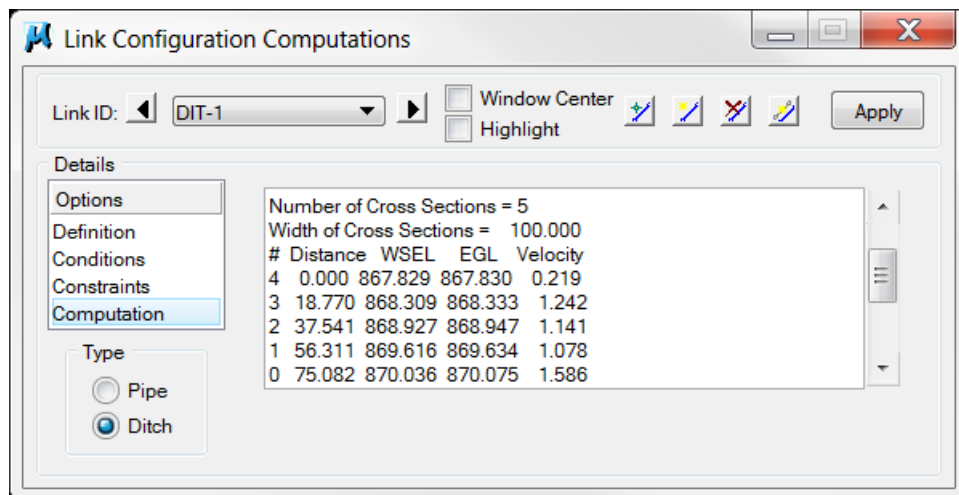
Set to link **DIT-1** and select **Computation**.



**Step 2.** Scroll down through the computation results to the data following the **Width of Cross Sections**.

This data represents conditions at each cross section drop along the link. Note that these points start at the end of the link and come back up the link to the beginning.

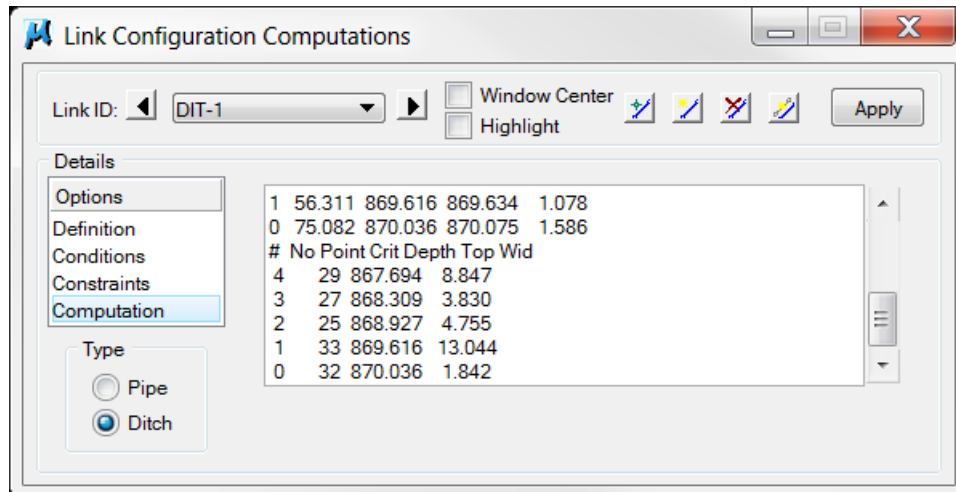
The first data group provides the cross section number (0-4 in this case with 5 cross sections), distance from end, water surface elevation, energy grade line elevation and velocity.



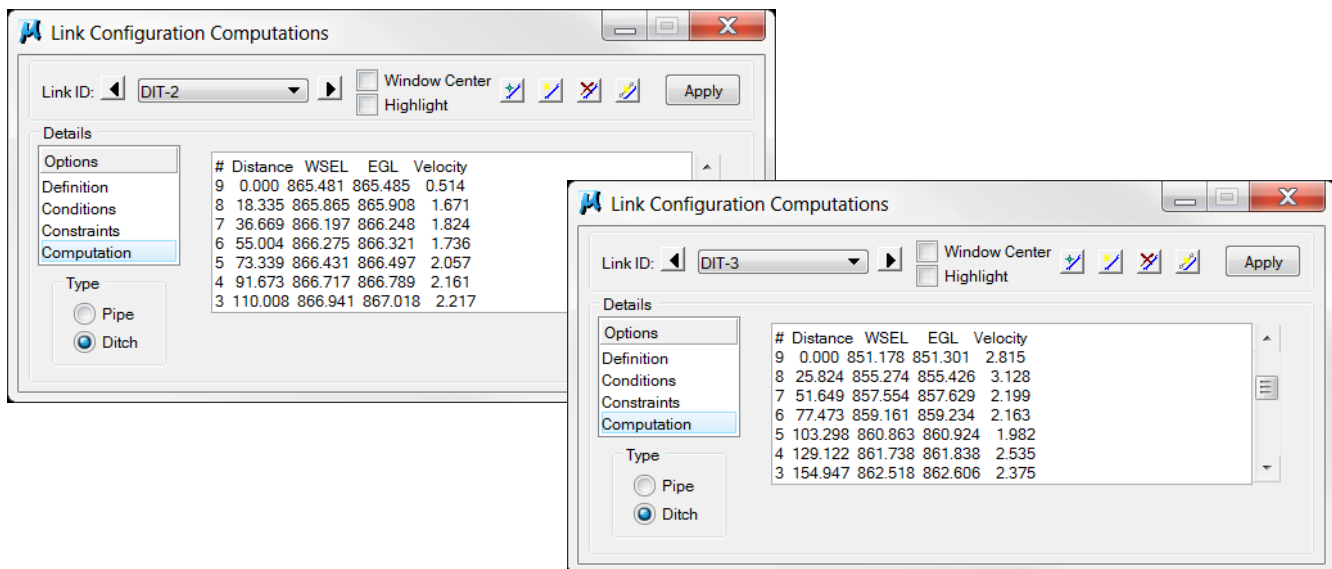
## Exercise 8

**Step 3.** Scroll down further to review the second data group.

The second data group provides the cross section number, number of slope break points in cross section, critical depth elevation, and top of water surface width.



**Step 4.** Switch to our other ditch links, DIT-2 & DIT-3, and review the computed data.



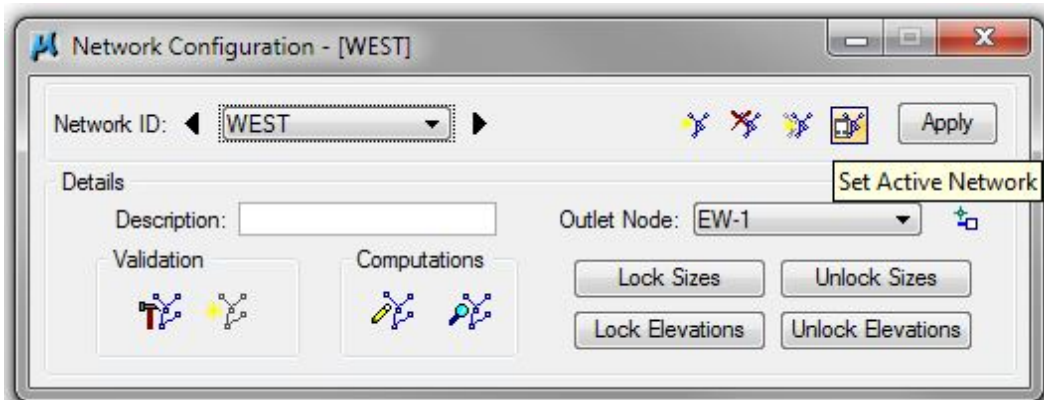
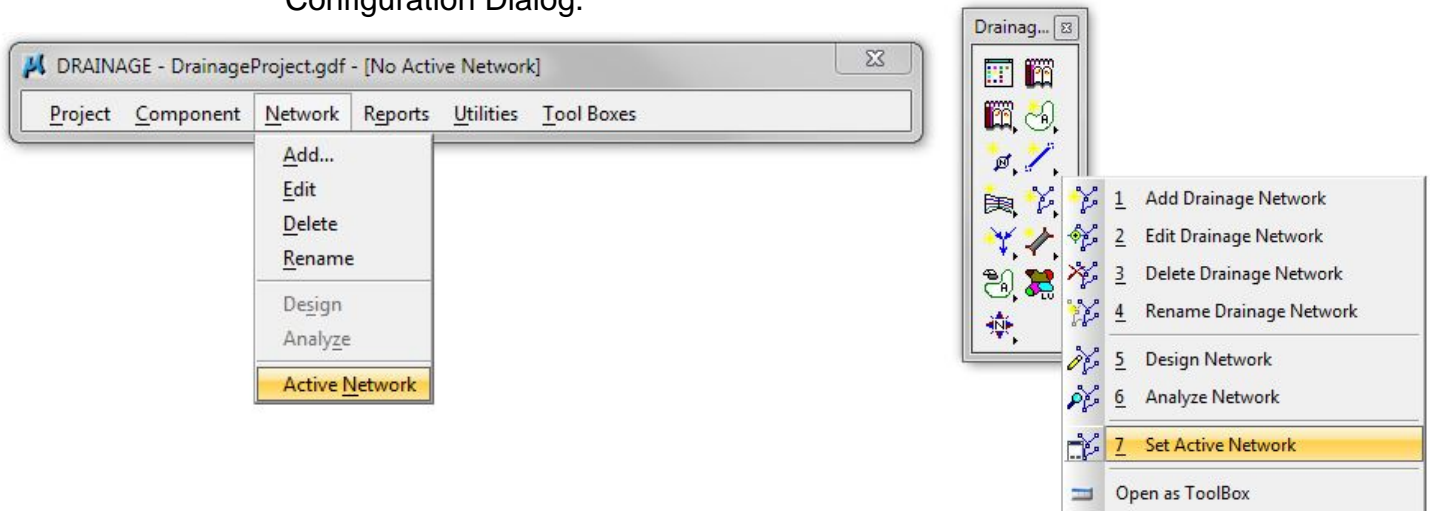
Using this information, we can determine if the existing conditions are adequate to convey the water along the fill line and critical points where more capacity may be required.

If using this methodology to analyze long proposed roadway ditches, you can determine locations where special ditches may be required as the depth\volume becomes too great for the regular ditch to handle.

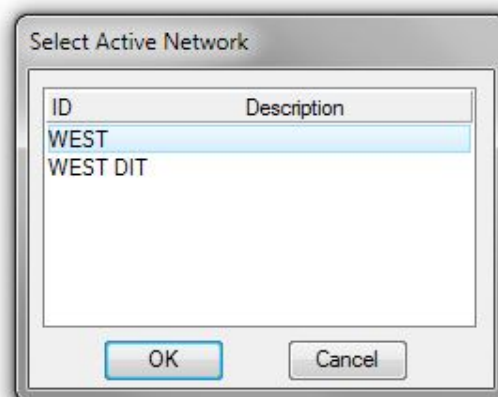
## 8.3 Choose Active Network

With the possibility of multiple networks in a single drainage project it may be necessary to choose an Active Network to utilize certain GEOPAK Drainage Features.

**Step 1.** Select the **Set Active Network** tool, select **Network > Active Network** from the main drainage menu bar or click the **Add Network** button in the Network Configuration Dialog.



**Step 2.** Select the network **West** and click **OK**.



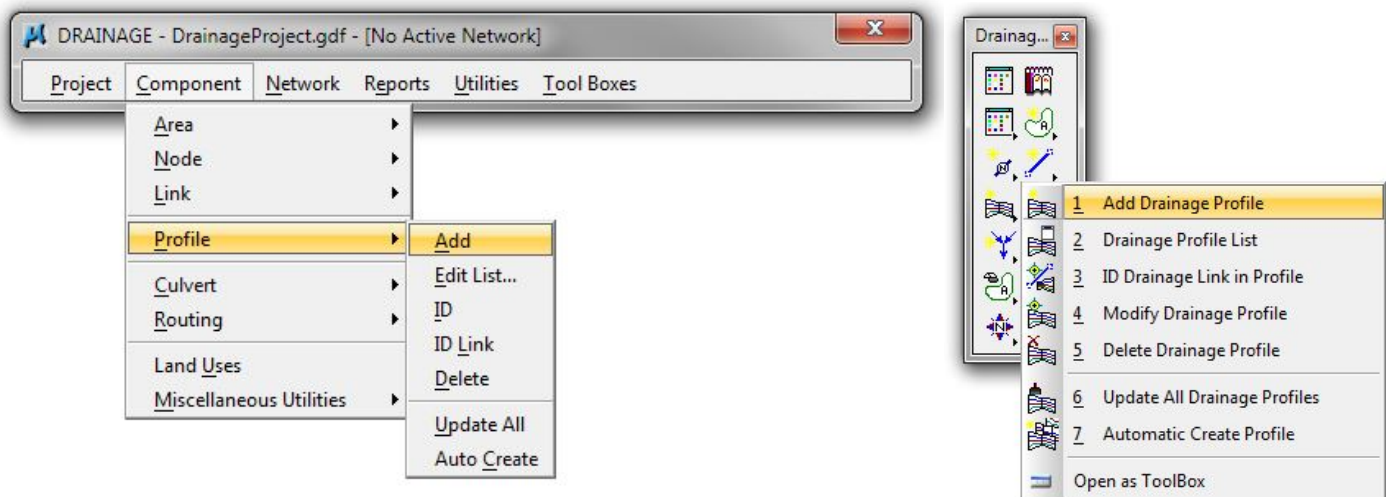
# Profiles

This exercise shows the user how to perform profile computations and properly display the drainage profile.

Profiles can be constructed in a path running in either direction, upstream or downstream, in a drainage network. The Profiles dialog is used to display customized profiles including groundline, nodes, links, depth of cover, hydraulic grade line, etc.

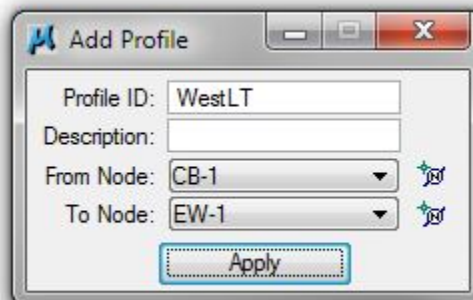
## 9.1 Storm Drainage Profile Design

**Step 1.** Select from the Menu Bar: **Component > Profile > Add** or from the main toolbar: **Add Drainage Profile**



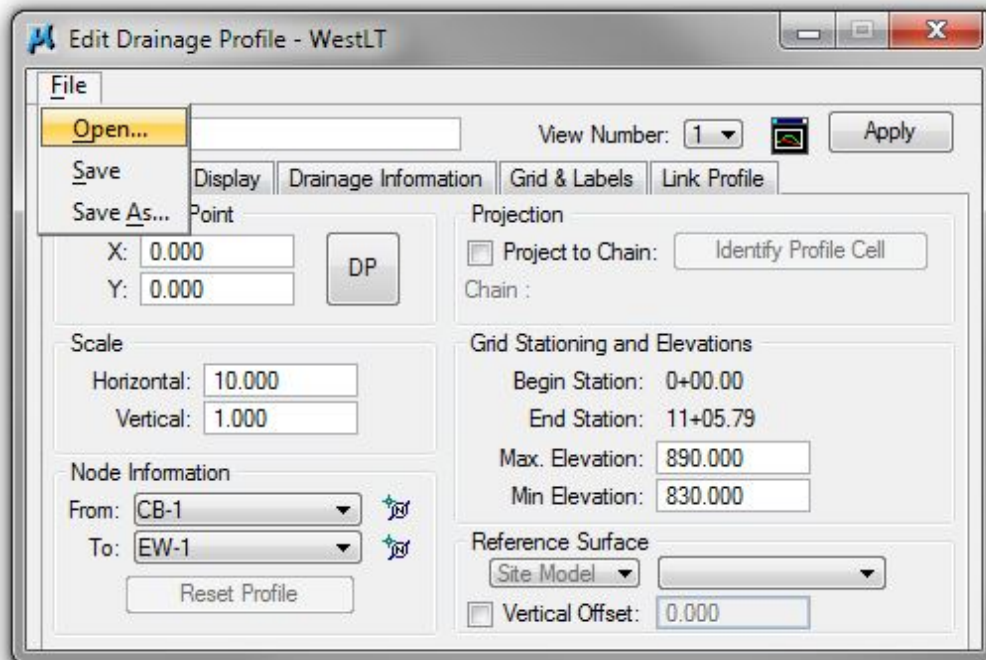
**Step 2.** Complete the **Profile Configuration** dialog box information as follows for the left side of the roadway in the WEST drainage network. Click **Apply** when finished.

**Profile ID:** WestLT      **From Node:** CB-1      **To Node:** EW-1

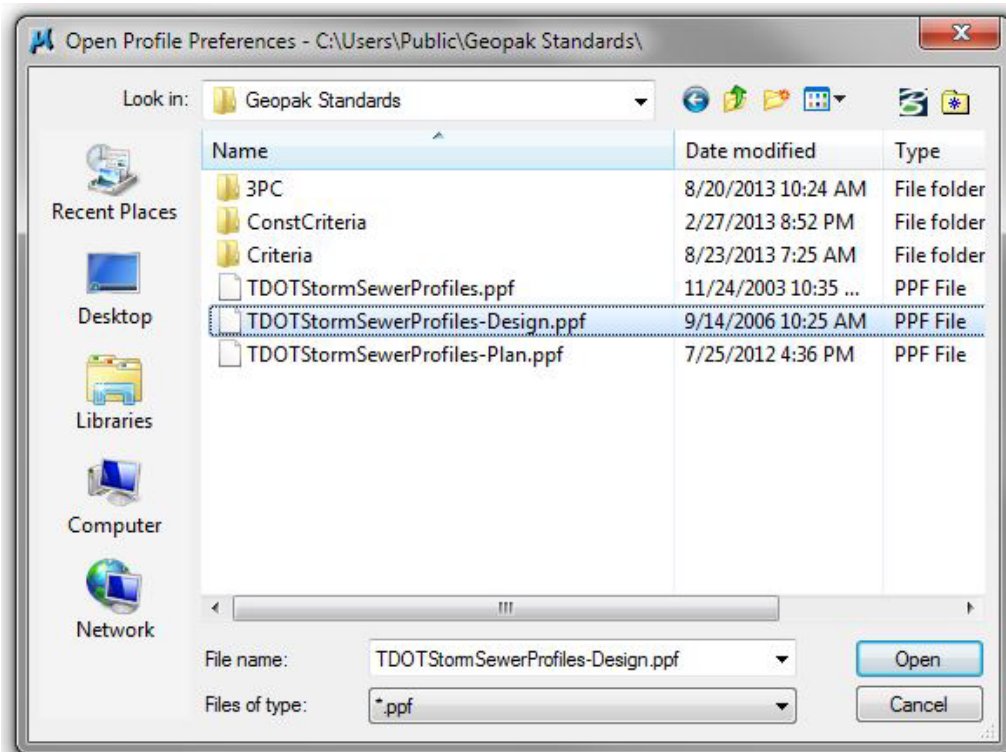


**NOTE:** To select the appropriate node; use the dropdown menu or use the **ID** node button and select the node from the plan view. **From Node** and **To Node** *must* be in the same network.

**Step 3.** Load the **Profile Preferences** file. Inside the Edit Drainage Profile dialog, click **File > Open**.



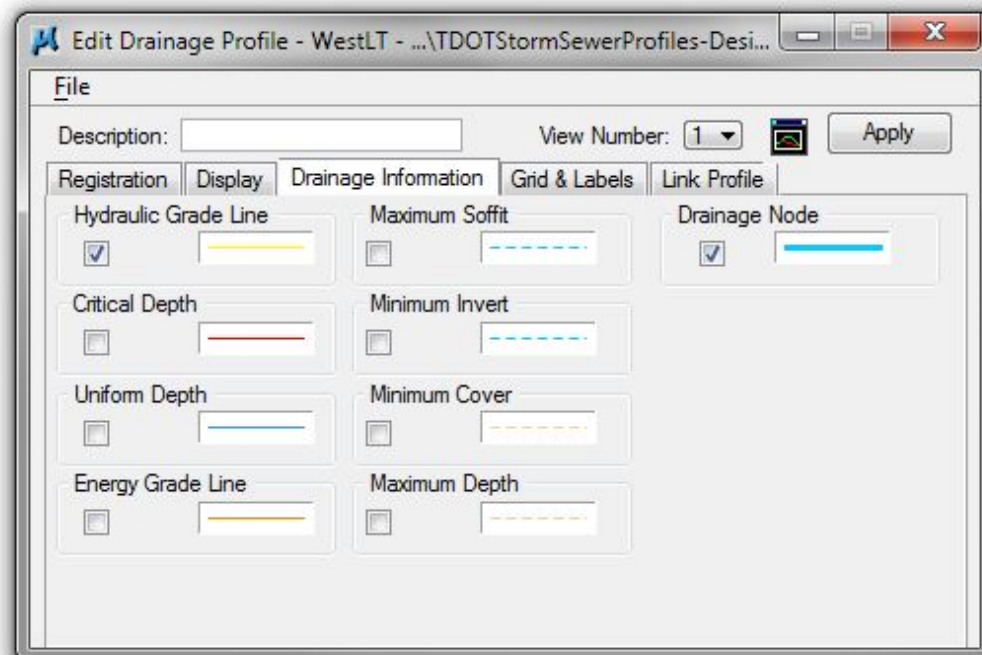
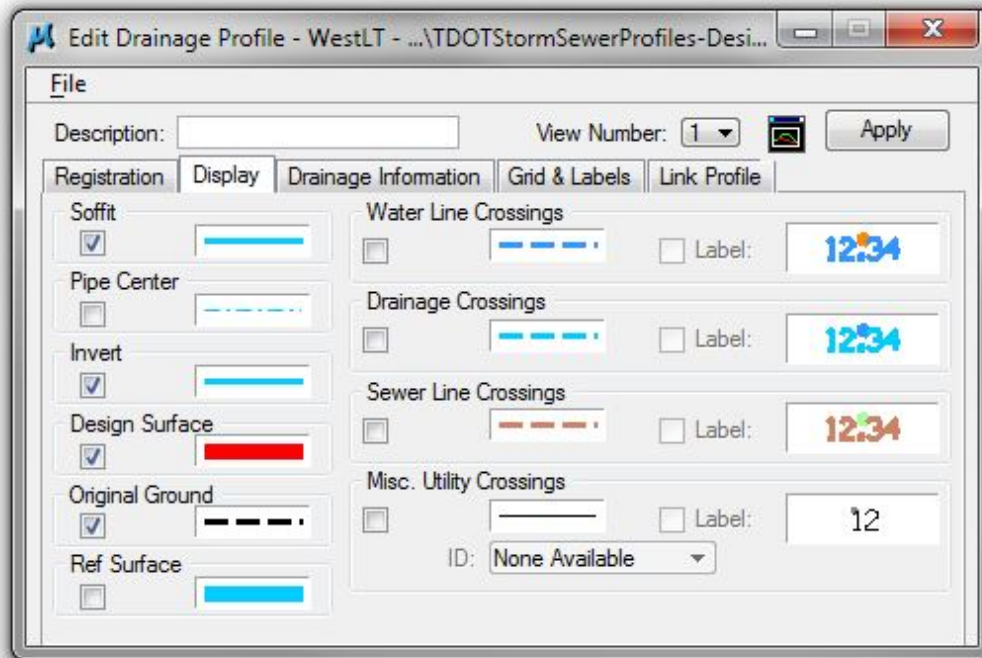
Navigate to **C:\Users\Public\Geopak Standards\** and select **TDOTStormSewerProfiles-Design.ppf**. Click **Open**.

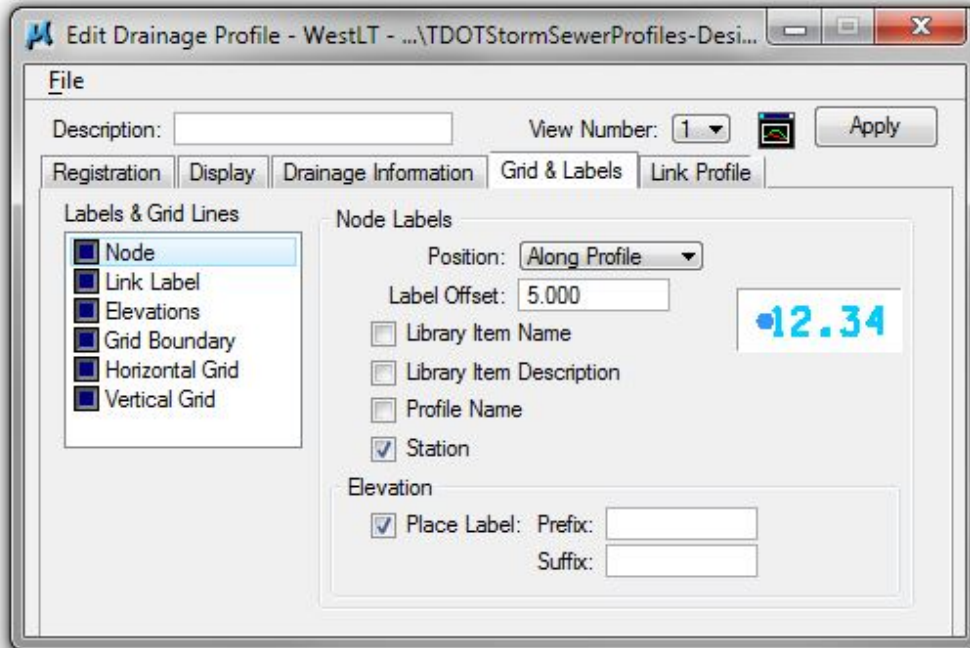




## Exercise 9

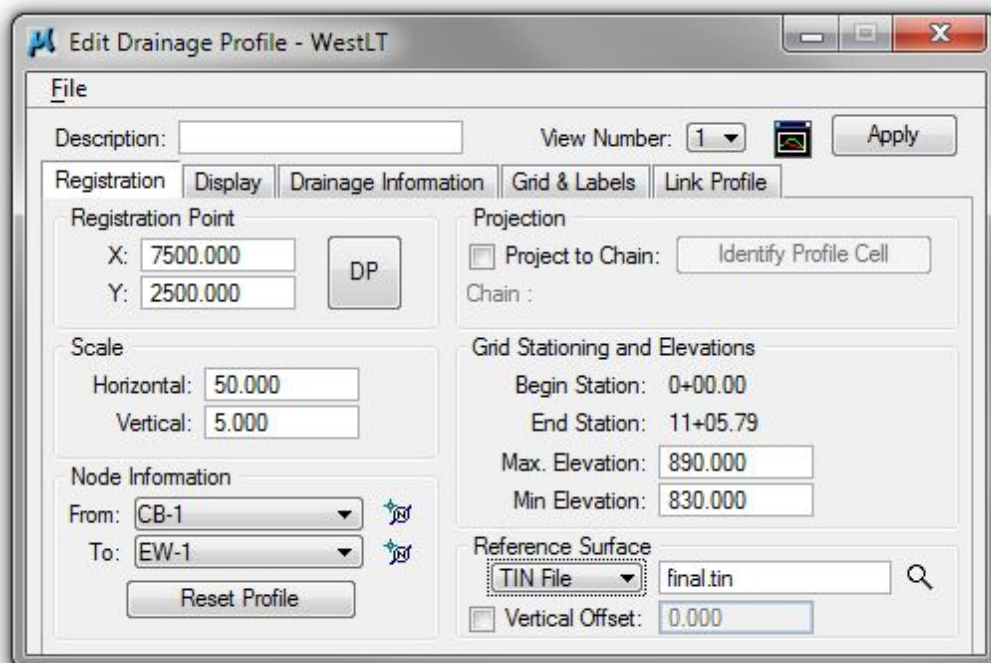
All settings have been set for the profile. To view the settings, click on the **Display**, **Drainage Information** and **Grid & Labels** tabs. They should look as shown below.



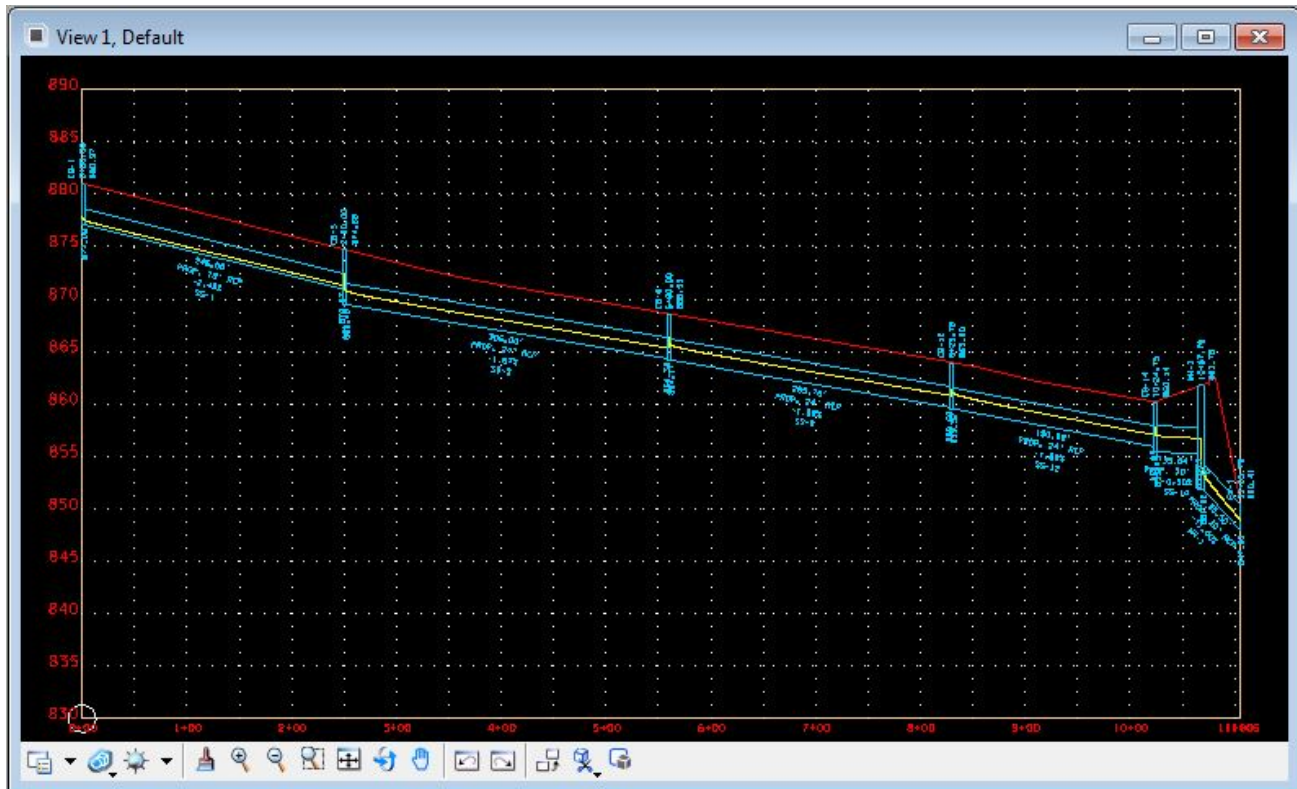


**NOTE:** During the design process these preferences can be modified to display needed information. However, when projecting to a profile (see Exercise 9.2) the settings should match those defined in profile preference file **TDOTStormSewerProfiles-Plan.ppf**.

**Step 4.** Click the **Registration** tab and make the settings as below in the *Registration Point*, *Scale* and *Reference Surface* portions (ignore the *Projection* portion for now). The Registration Point will correspond to the lower left corner of the profile and can be wherever an open space is available. Click **Apply**.



## Exercise 9



**Step 5.** Review the profile for anything that needs to be corrected.

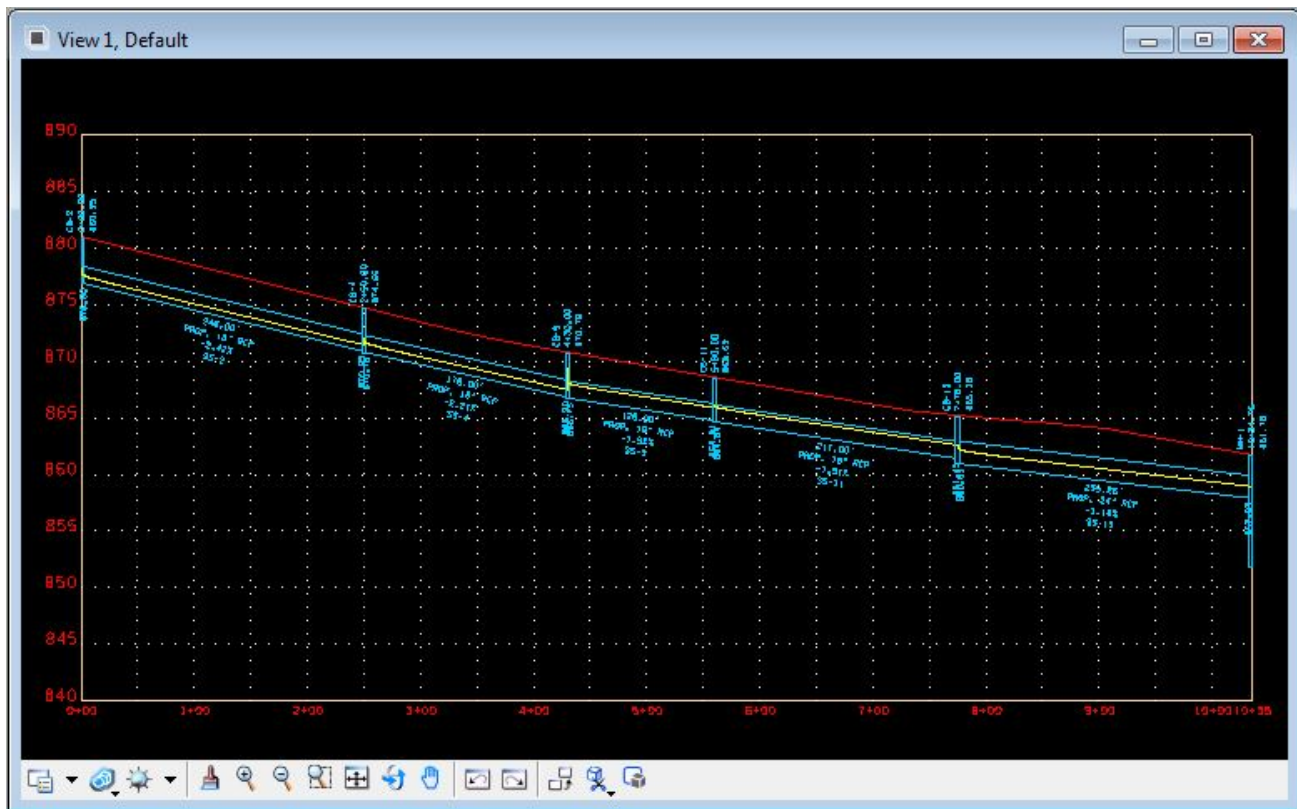
**Step 6.** Repeat steps 1-4 to create the following profiles:

Profile ID	From Node - To Node
WestRT	CB-2 - MH-1
CB5	CB-5 - CB-2
CB7	CB-7 - CB-3
CB8	CB-8 - CB-6
CB10	CB-10 - CB-9

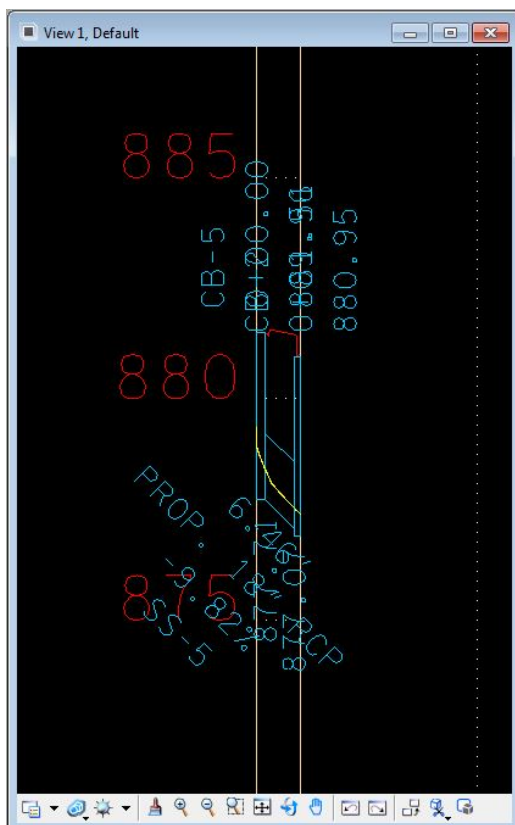
**NOTE:** All Profiles should go forward with the alignment so they can be projected to the roadway alignment profile at a later time.

See the following pages for images of the profiles.

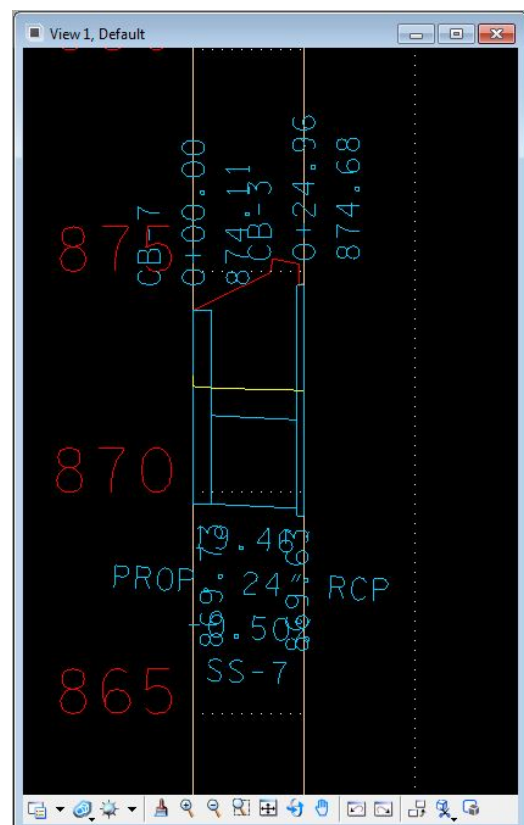
## WestRT



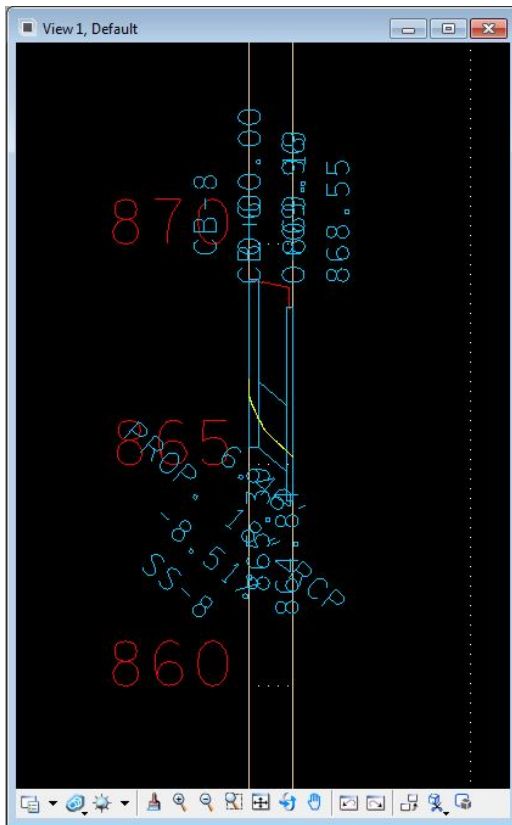
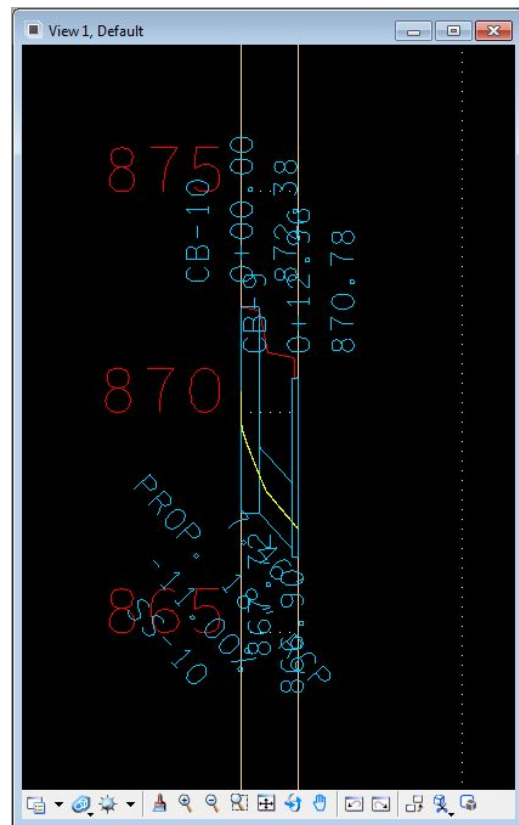
CB5



CB7



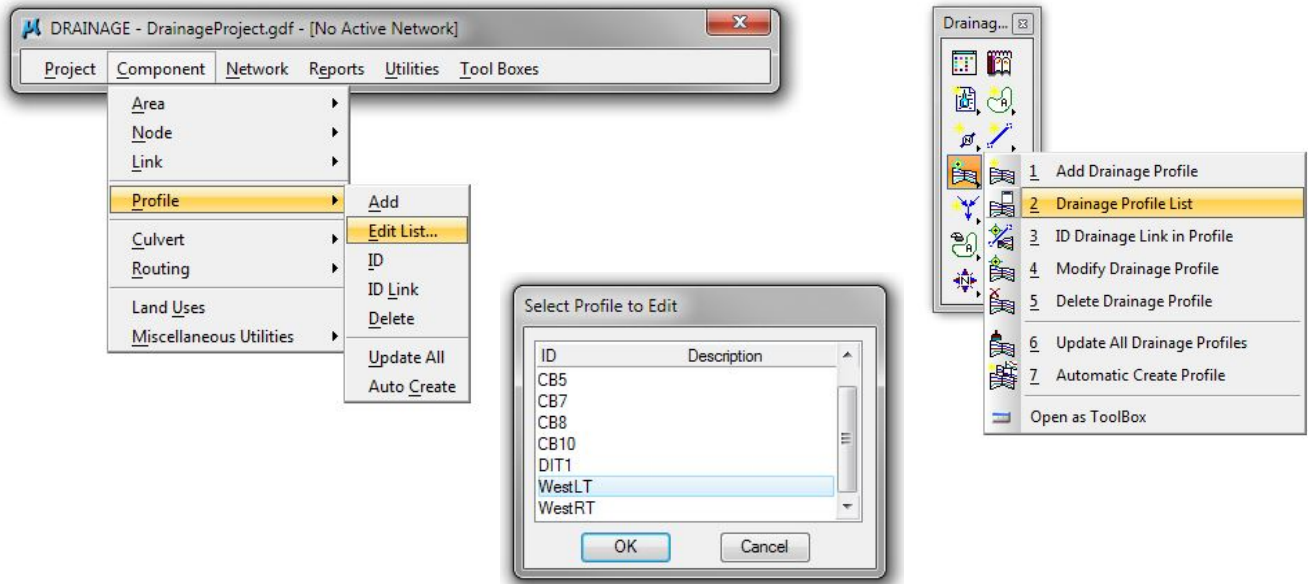
## Exercise 9

**CB8****CB10**



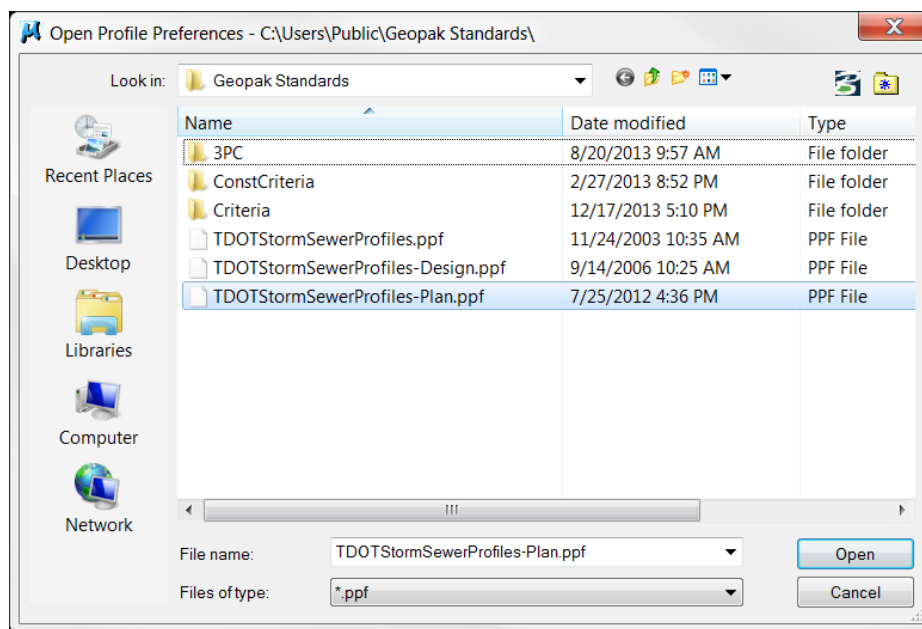
## 9.2 Projecting Final Storm Drainage Profiles

**Step 1.** Click **Component > Profile > Edit List** from the GEOPAK Drainage Menu or by **Drainage Profile List** from the Drainage Toolbar and select the Profile **WestLT**. Click **OK**.



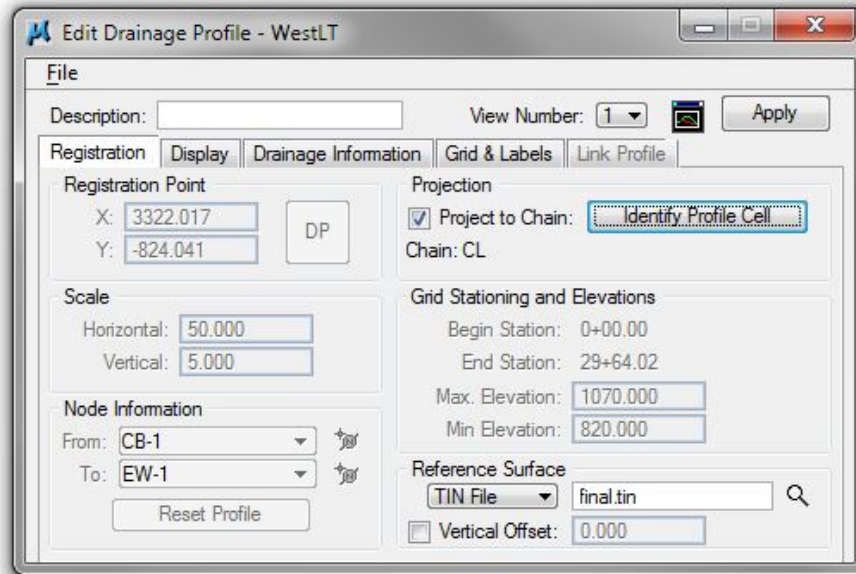
**Step 2.** Load the **Profile Preferences** file. Inside the Edit Drainage Profile dialog, click **File > Open**.

Navigate to **C:\Users\Public\Geopak Standards\** and select **TDOTStormSewerProfiles-Plan.ppf**. Click **Open**.

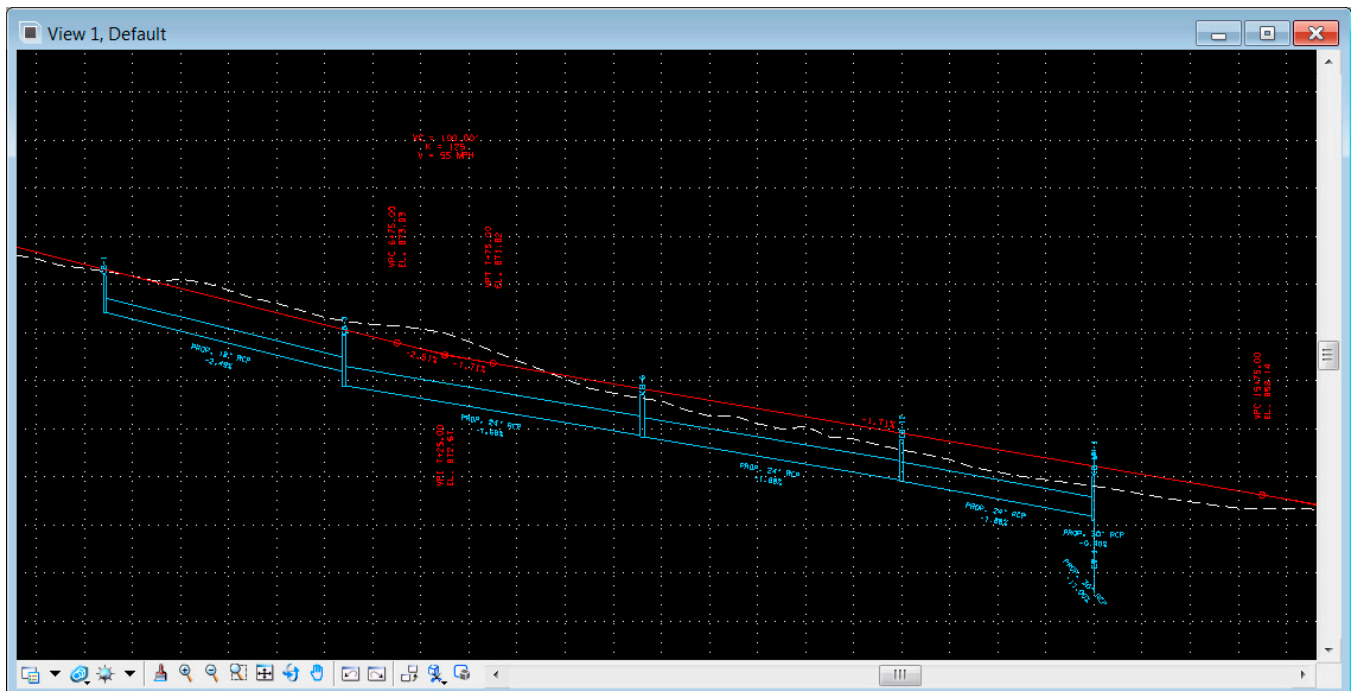


## Exercise 9

- Step 3.** Toggle **ON** **Project to Chain** in the *Projection* portion of the dialog. Click **Identify Profile Cell**, select the Profile Cell for the *Roadway Profile* and Data Point to accept. Click **Apply**.



- Step 4.** View the Projected Drainage Profile along the Roadway Profile.



**NOTE:** Caution must be used when Projecting Profiles since the profile will be skewed to fit the station and elevation data of the profile.

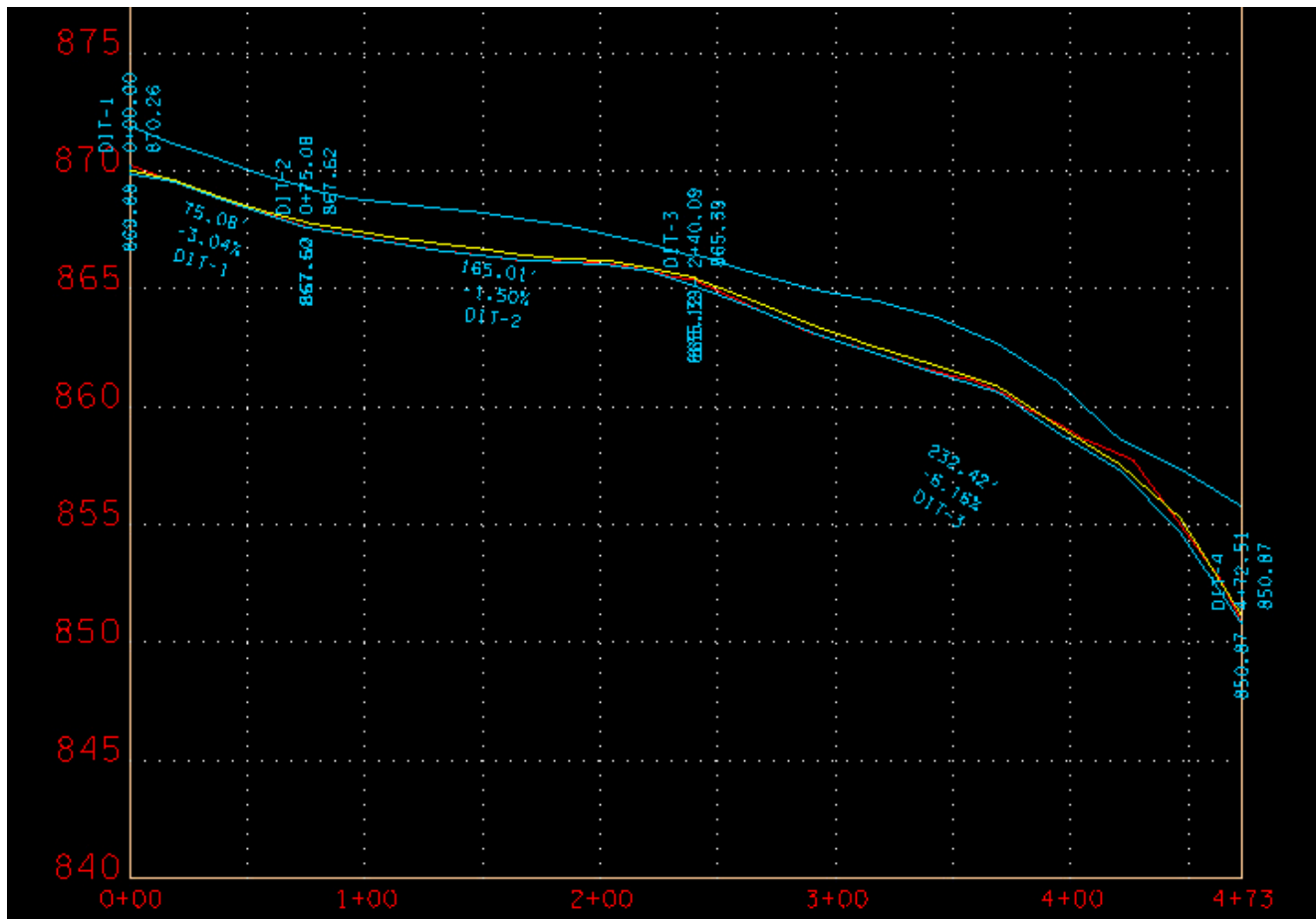
## 9.3 Ditch Profiles

- Step 1.** Select from the Menu Bar: **Component > Profile > Add** or from the main toolbar: **Add Drainage Profile**
- Step 2.** Complete the **Profile Configuration** dialog box information as follows for the special ditch drainage network. Click **Apply** when finished.
- Profile ID:** DIT1      **From Node:** DIT-1      **To Node:** DIT-4
- Step 3.** Load the **Profile Preferences** file. Inside the Edit Drainage Profile dialog, click **File > Open**. Navigate to **C:\Users\Public\Geopak Standards\** and select **TDOTStormSewerProfiles-Design.ppf**. Click **Open**.
- Step 4.** Click the **Registration** tab and make the settings as below in the *Registration Point*, *Scale* and *Reference Surface* portions (make sure **Project to Chain** is toggled OFF). Click **Apply**.

The screenshot shows the 'Edit Drainage Profile - DIT1' dialog box with the 'Registration' tab active. The 'Registration Point' section contains input fields for X (8920.810) and Y (-548.580) with a 'DP' button. The 'Scale' section has 'Horizontal' (50.000) and 'Vertical' (5.000) fields. The 'Node Information' section shows 'From' as DIT-1 and 'To' as DIT-4, with a 'Reset Profile' button. The 'Reference Surface' section includes a 'TIN File' dropdown set to 'final.tin' and a 'Vertical Offset' field set to 0.000. The 'Projection' section has an unchecked 'Project to Chain' checkbox. The 'Grid Stationing and Elevations' section displays 'Begin Station: 0+00.00', 'End Station: 4+72.51', 'Max. Elevation: 920.000', and 'Min Elevation: 840.000'. An 'Apply' button is located in the top right corner.

**NOTE:** For ditch profiles defined with Fixed Geometry, this dialog can be used to help identify and correct errors produced in the drainage calculations and ensure the drainage flows as it should. Our current ditch network set up is Cross Section Based on the existing terrain so that functionality is not applicable.

## Exercise 9



### NOTES:

For Crossed Section Based links the invert follows the existing surface terrain.

The hydraulic grade line indicates locations where the existing ditch cross section geometry and water volume cause a rise or fall in the water surface elevation. Rises indicate points where greater capacity may be required. This information along with computation information provided with the links can be used to determine any possible special ditch needs.

In the system modification chapter we will relocate these nodes and set the links as fixed geometry to define a special ditch set up to handle the drainage in this area.

## 9.4 Editing Links via Profiles

The Edit Profiles dialog allows you to edit a Link's design. This being the case the **Link Configuration** dialog must be closed in order to open the **Edit Drainage Profile** dialog.

**Step 1.** Open profile **WestRT** by selecting **Component > Profile > Edit List** or by selecting **Drainage Profile List** from the GEOPAK Drainage Main Toolbar.

**Step 2.** Click the **Link Profile** tab. Highlight the **SS-2** Link ID.

Link ID	Node	Elevation	Node	Elevation	Slope
SS-2	CB-2	876.903	CB-4	870.954	2.418
SS-4	CB-4	870.784	CB-9	867.070	2.110
SS-9	CB-9	866.570	CB-11	864.308	1.795

**Details**

Node  
Min. Cover: 878.403  
☐ Hold Invert: 876.903

Node  
Min. Cover: 872.454  
☐ Hold Invert: 870.954

Drainage Library Item  
18 Inch Dia. Circular

☐ Hold Slope: 2.418

☐ Center View: 1

The SS-2 link's control data is populated in the **Details** section at the bottom.

Link ID	Node	Elevation	Node	Elevation	Slope
SS-2	CB-2	876.903	CB-4	870.954	2.418
SS-4	CB-4	870.784	CB-9	867.070	2.110
SS-9	CB-9	866.570	CB-11	864.308	1.795

**Details**

Node  
Min. Cover: 878.403  
☐ Hold Invert: 876.903

Node  
Min. Cover: 872.454  
☐ Hold Invert: 870.954

Drainage Library Item  
18 Inch Dia. Circular

☐ Hold Slope: 2.418

☐ Center View: 1

Modify Segment

From here you can set and hold the invert elevations, set the slope to hold or change the pipe size.

Once any desired changes are made, click the **Modify Segment** icon on the right. An alert will appear. Click **Yes**, review and dismiss the warnings.

**Step 3.** Do not make any changes at this time, click the red **X** to dismiss the dialog.

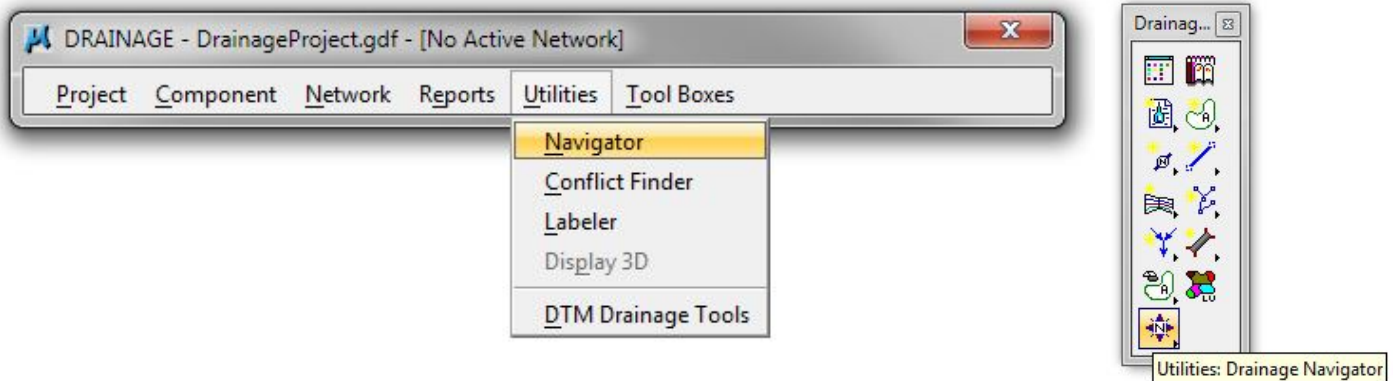


# Drainage Navigator

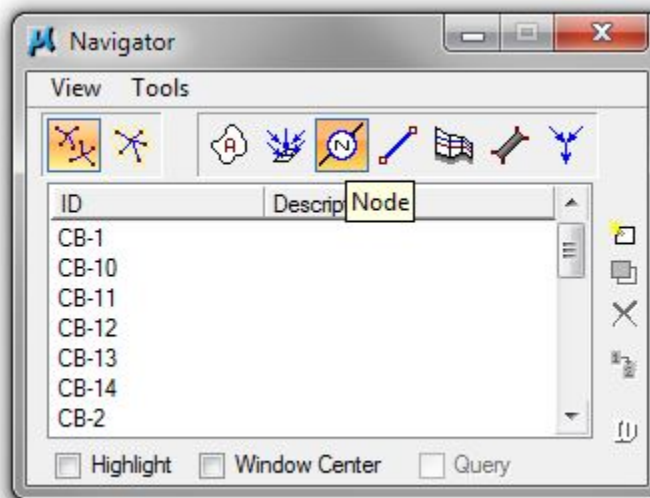
This exercise shows the user how to navigate the network and perform queries.

## 10.1 Navigating/Query

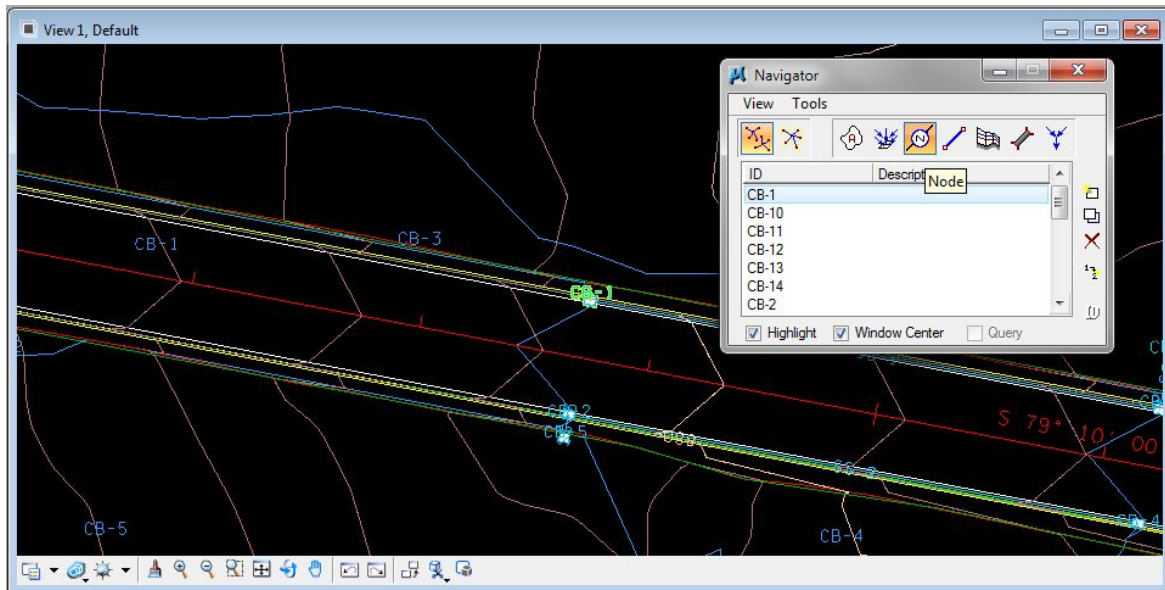
- Step 1.** Select from the Drainage Menu Bar **Utilities > Navigator** or from the drainage main toolbar **Drainage Navigator**.



- Step 2.** Select the Drainage **Nodes** button on the *Navigator*.



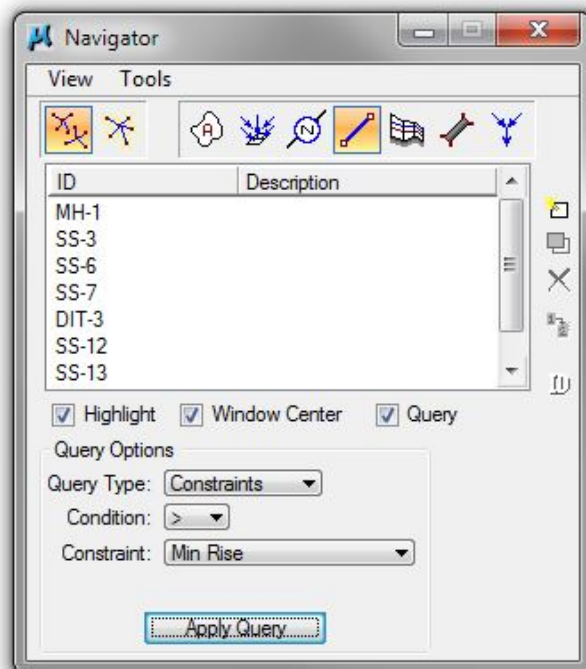
- Step 3.** Toggle ON the **Highlight** and **Window Center** tools and click **once** on various nodes in the network.



As you can see the **Drainage Navigator** makes it easy to go to specific components in the network. A **double click** automatically opens the component's configuration dialog for easy editing of any Drainage component.

**Step 4.** Set the Active Component Type to **Link** and toggle the **Query** option:

**Step 5.** Use the Query tool to determine which Links have exceeded the Min Rise. Make the settings as shown and then click on **Apply Query**.



Note the results of your query here:

---

**Step 6.** Follow the same procedures to determine the following:

Using Query type **Values**;

Which pipes have a velocity greater than 3 fps?

---

Using Query type **Constraints**;

Which pipes have exceeded their maximum rise/diameter?

---

Using Query type **Constraints**;

Which inlets have exceeded their max ponded width?

---

Using Query type **Values**;

Which areas have a "C" values greater than 1.0?

---

## 10.2 Navigating/Global Editor

From the query in **Step 5** of Exercise 10.1 you should have found that 7 pipes were designed at a value greater than the minimum rise 1.5' (18"). These should have been SS-3, SS-6, SS-7, SS-12, SS-13, SS-14 and SS-MH1.

Since for the initial design we set our minimum depth of cover based on the minimum pipe size it will be necessary to check our catch basin depths to be sure they have not violated minimum depth requirements and to make sure that the larger pipe size is valid for the node which was used. To do this take the following steps:

### Checking Minimum Depth Requirements vs. Designed Node Depths & Pipe Sizes:

**Step 1.** Identify which drainage nodes are involved by going to **Reports > Storm Drains/Links > Link Configuration** in the GEOPAK Drainage menu bar. This report describes each link including From Node (Upstream), To Node (Downstream) and Size/Diameter (Rise).

The screenshot shows the GEOPAK Drainage software interface. The main window is titled "DRAINAGE - DrainageProject.gdf - [WEST Active]". The menu bar includes Project, Component, Network, Reports, Utilities, and Tool Boxes. The Reports menu is open, showing options like Drainage Areas, Inlets, Storm Drains/Links, Builder..., and Generate. The Storm Drains/Links menu is further open, showing Link Configuration and Link Hydraulic Computations. A secondary menu is also open, listing actions such as Add Drainage Link, Edit Link, Delete Drainage Link, and Drainage Link Report - Configuration (which is highlighted).

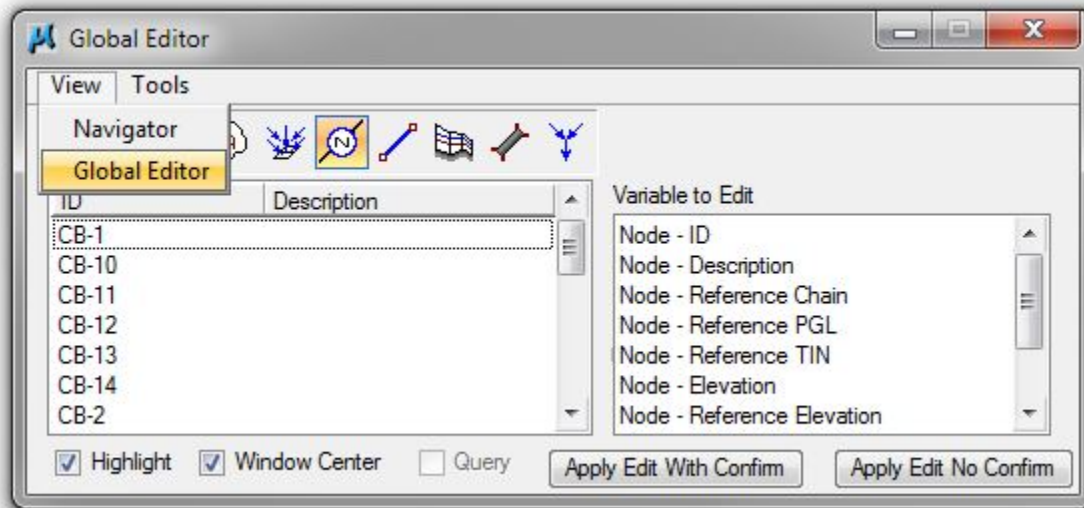
Below the menu navigation, the "Storm Drain Configuration Summary for Network WEST - Calculations Current" window is displayed. It contains a table with the following data:

Upstream		Downstream									Upstream		Downstream
ID	ID	ID	Discharge	Length	Shape	#	Rise	Span	n	Slope	Invert	Invert	
MH-1	MH-1	EW-1	31.394	35.500	Circul	1	2.500	n/a	0.013	11.000	851.817	847.912	
SS-13	CB-13	MH-1	12.711	255...	Circul	1	2.000	n/a	0.013	1.182	860.949	857.932	
SS-14	CB-14	MH-1	19.307	39.040	Circul	1	2.500	n/a	0.013	0.500	855.429	855.233	
SS-11	CB-11	CB-13	12.153	211...	Circul	1	1.500	n/a	0.013	1.512	864.638	861.449	
SS-12	CB-12	CB-14	18.063	190...	Circul	1	2.000	n/a	0.013	1.881	859.522	855.929	
SS-9	CB-9	CB-11	11.711	126...	Circul	1	1.500	n/a	0.013	1.525	866.730	864.808	
SS-6	CB-6	CB-12	17.420	265...	Circul	1	2.000	n/a	0.013	1.684	864.168	859.692	
SS-4	CB-4	CB-9	5.670	176...	Circul	1	1.500	n/a	0.013	2.207	870.784	866.900	
SS-10	CB-10	CB-9	4.536	7.460	Circul	1	1.500	n/a	0.013	11.000	867.720	868.400	
SS-3	CB-3	CB-6	14.381	306...	Circul	1	2.000	n/a	0.013	1.675	869.463	864.338	

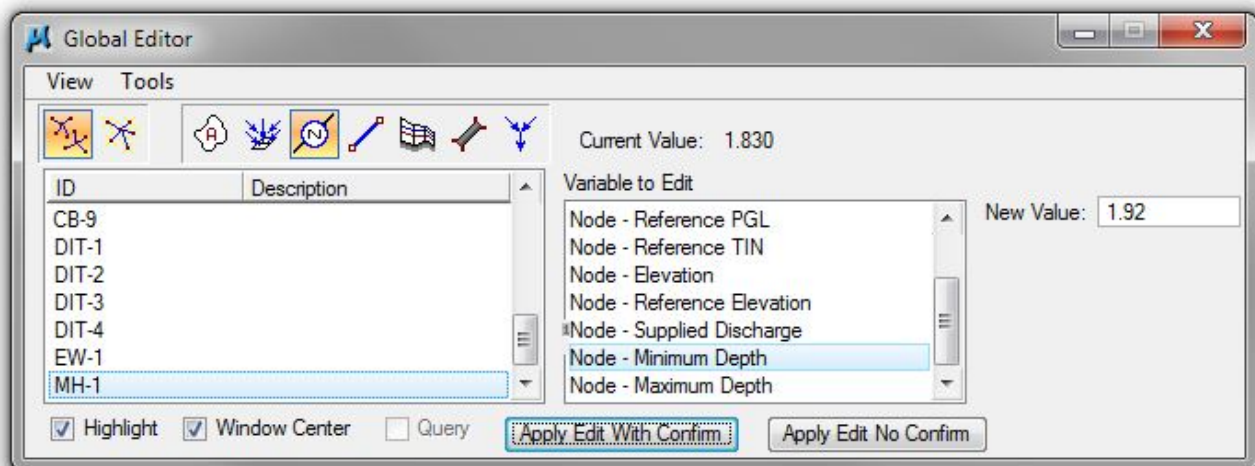
At the bottom of the window, there is an "ASCII File:" field, a search icon, an "Edit" button, checkboxes for "Window Center" and "Highlight", and an "Apply" button.

## Exercise 10

- Step 2.** Open the **Navigator** tool and expand it to the Global Editor by choosing from the pull-down menu **View > Global Editor**. Once the Global Editor is open, click on the **Node** button.



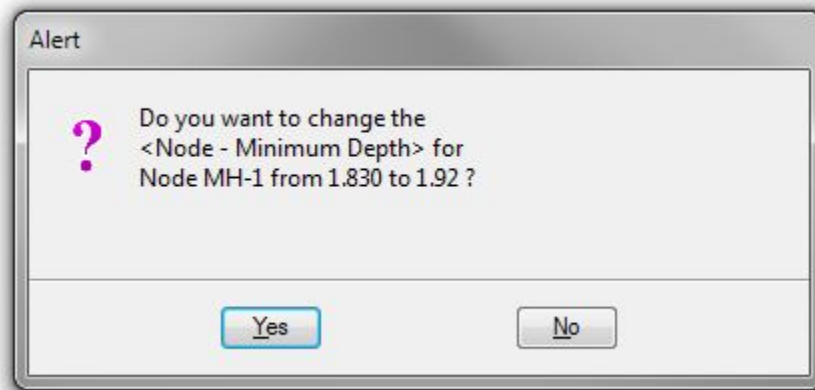
- Step 3.** SS-MH1 is the first link shown in the Storm Drain Configuration Summary (**Step 1**). This link was designed with to have a rise of 2.5 feet (30 inches). Find and select the Upstream Node (From Node) MH-1 for this Link in the Global Editor Dialog, then find and select **Node – Minimum Depth** in the *Variable to Edit* portion of the editor. Set the **New Value** to the correct minimum depth for a 2.5' (30") diameter pipe found in the [TDOT GEOPAK Drainage Nodes](#) document (Appendix A).



**NOTE:** If the type of structure for a given node is unknown or needs to be changed (would happen if pipe size is too large for a given catch basin), simply double click the **Node ID** in the Global Editor and the Node Configuration Dialog will be invoked.



**Step 4.** Click **Apply Edit With Confirm** to apply the New Value and Click **Yes** in the Alert box.



**NOTE:** Global Editor may be used to edit multiple Nodes/Links at once.

**Step 5.** Repeat the previous steps to correct the minimum depth settings for other storm drainage nodes as needed for pipe links SS-3, SS-6, SS-7, SS-12, SS-13 and SS-14.

**NOTE:** Since CB-13 and CB-14 have unequal inlet & outlet pipe sizes, you will need to add the drop across bottom of structure to the minimum depth of cover value to ensure minimum depths are maintained. Node CB-7 only has an outlet so the same is required for it as well.

**Step 6.** Re-design the network and review your profile. The Nodes should now meet minimum depth requirements.

**Step 7.** For Links SS-14 and SS-MH1 change the minimum rise to 3.0 and ensure all Nodes have the correct minimum depth for that pipe size.

**NOTE:** Node CB-14 is too small for a 36" in the narrow side of the structure, however, it is still ok for it to be in the wide side of the structure. This is signified by a **W** to the left of the minimum depth of cover values in the T.D.O.T. Geopak Drainage Nodes tables.

From the third query in Exercise 10.1 you should have found that inlet CB-13 exceeded the maximum ponded width (8' allowable spread.). This is probably due to the change in cross slope of the roadway. To finalize the design for this drainage network the catch basin spacing and its associated drainage area would need to be adjusted to keep the spread within allowable limits.

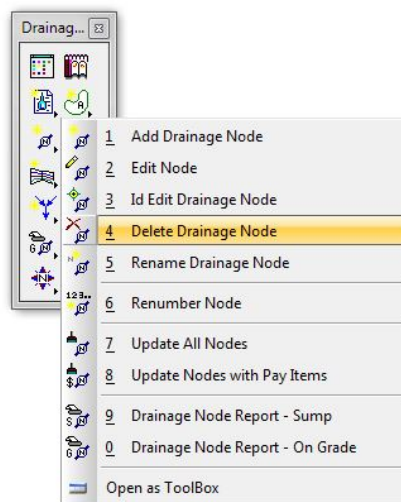
**It is recommended that once a drainage network is set up all component constraints should be reviewed to insure that all criteria for design has been met.**

## System Modification

This exercise shows the user how to modify the storm drainage system design. Specifically we will combine links SS-14 & SS-MH1, change SS-13 to end at CB-12 and eliminate MH-1, reengineering the network connectivity. We will also change our ditch network set up to define a special ditch to handle the drainage along the base of the fill slope in that area.

### 11.1 Storm Drainage Network Modification

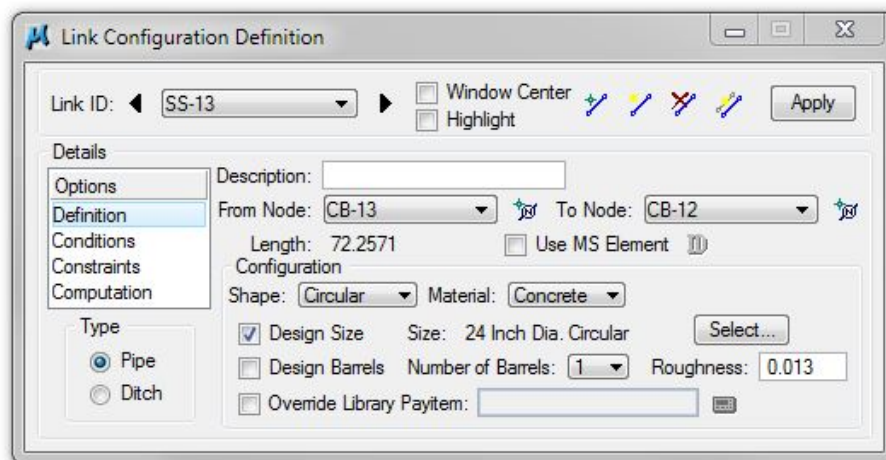
- Step 1.** Delete **Node MH-1** by using **Drainage Navigator**, selecting **Component > Node > Delete** from the Drainage Menu Bar, or by selecting **Delete Drainage Node** from the Drainage Toolbar.



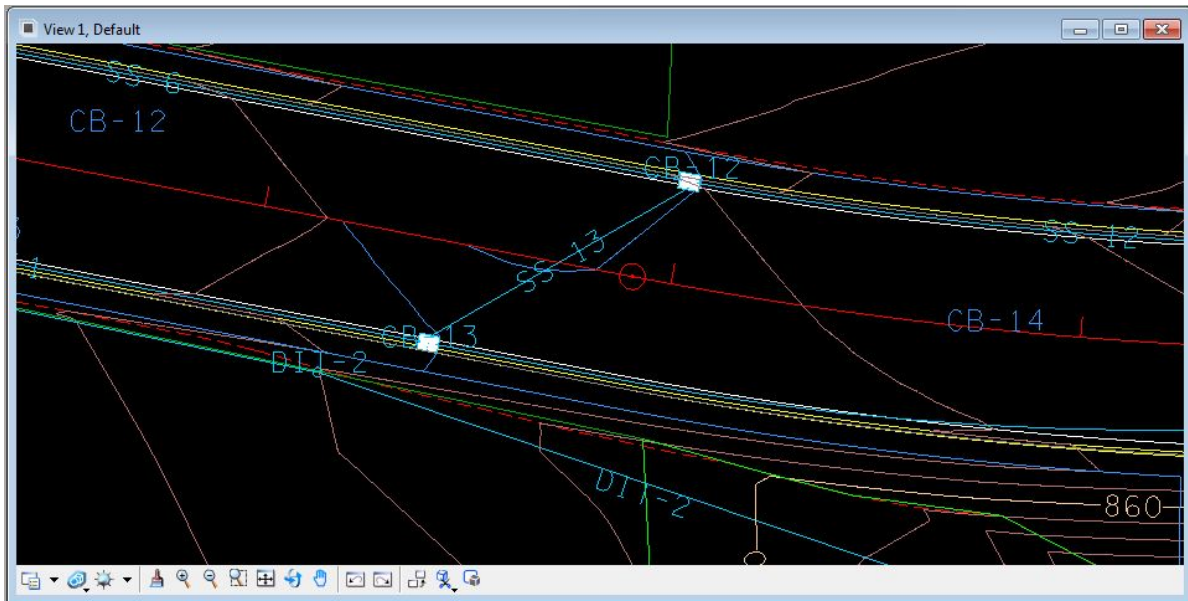
**NOTE:** Click **Yes** that you would like to delete the Node, **OK** to delete the Network WEST and **NO** to *Do you want to delete all the components of the network as well?*

- Step 2.** Follow the same basic procedures to delete **Link SS-MH1**.

- Step 3.** Edit Link SS-13, to start at the front face of CB-13 towards centerline and end at the front face of Node CB-12 across the road.



**REMINDER:** Use the **ID** button to the right of the node list to identify the front wall connection points at nodes CB-13 and CB-12.

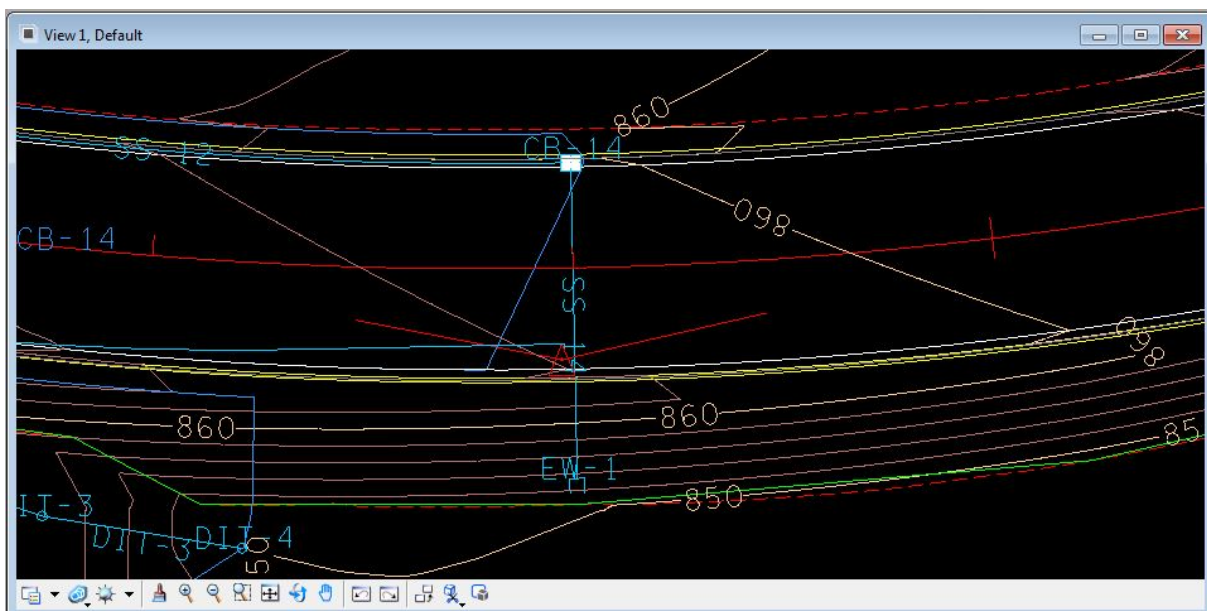


**NOTE:** In an actual design, the skew angles would now need to be checked to ensure the pipe would fit in the catch basin wall.

**Step 4.** Edit Link SS-14, to go to Node **EW-1**.

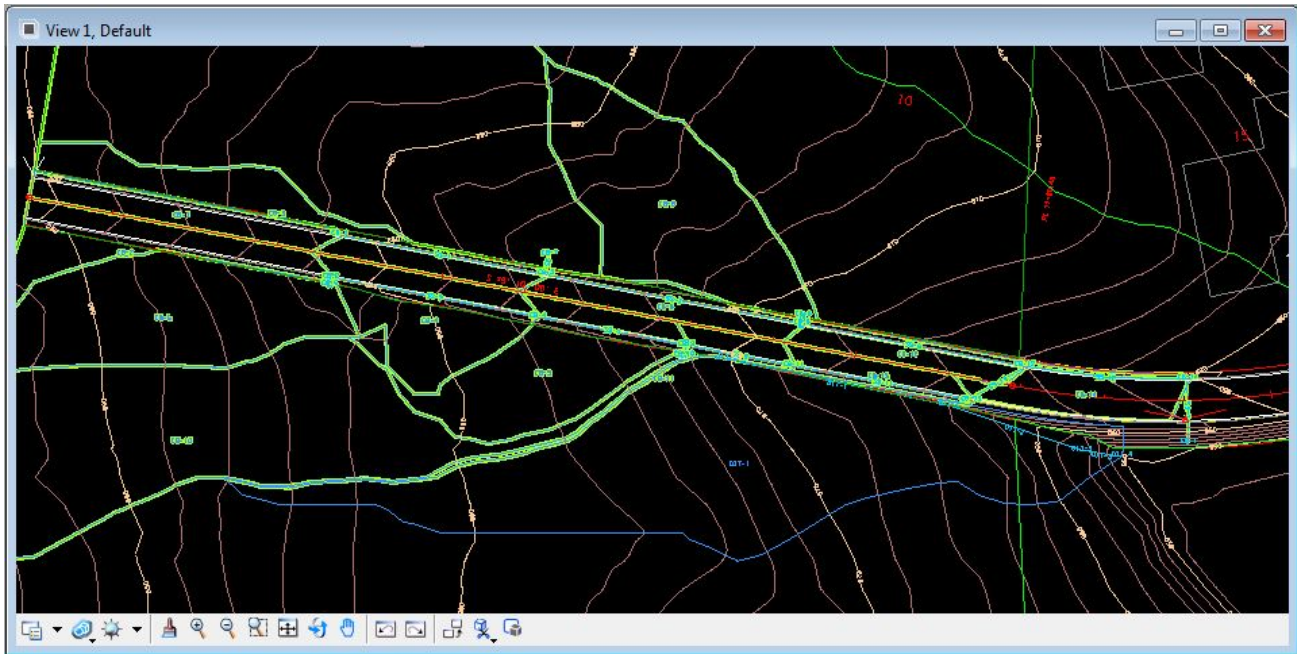
**Step 5.** Since pipe at EW-1 is now a 36" pipe (from previous exercise) and the side slope at that location is 2:1, move the location of the outlet from an offset of 56' to 50' to account for the length of the end wall and properly locate the outlet.

**Step 6.** Reset EW-1's Max Depth to 3.0 (designed pipe size at outlet).



## Exercise 11

**Step 7.** Add a New Network named **WEST** with the Outlet Node set to **EW-1** (this is necessary since the network was deleted in **Step 1**). Highlight the Network to ensure all components are connected, then Design the Network.



**Step 8.** Update Profile **WestRT** to End at CB-12 and redraw other profiles as required based on these modifications.

### Optional:

Depending on the drainage areas developed in the previous exercises you may still have errors in your network. If your hydraulic gradeline exceeds the minimum freeboard, try increasing pipe sizes to lower the water surface. If the velocity in Link SS-14 is over the maximum limit try hard coding SS-14's invert elevation at Node CB-14 to lower the slope of that Link.

## 11.2 Ditch Network Modification

Initially, we set up a ditch network along a fill line using the Cross Section Based ditch type to analyze the drainage there. Now we will relocate our ditch nodes and set up our links as fixed geometry to design a special ditch along that slope to handle the drainage.

### Relocate Ditch Nodes and their Drainage Areas

**Step 1.** Go to **Component > Node > Edit** and select Node DIT-1.

Under **Location**, change the station to **9+25** and the offset to **35.23**.

This is the beginning of the desired special ditch at the base of the fill slope. We will define the ditch link later as a “V” ditch with 2:1 side slopes although it will be at the existing ground elevation here at the beginning.

The dialog box shows the configuration for Node DIT-1. The 'Location' tab is selected in the left sidebar. The 'Chain' is set to 'CL' and the 'Profile' is 'DESIGNCL'. The 'Coordinates / Stationing' section shows 'Align' as 'Tangent to Chain', 'Station' as '9+25.00', 'Offset' as '35.230', and 'Offset from Gutter to Inlet' as '0.000'. The coordinates are X: 3484.943 and Y: 3056.086. The 'Angle' is 0.000. The 'Mirror Node' checkbox is unchecked. The 'Apply' button is visible in the top right.

Click **Apply**.

**Step 2.** Use methods described previously to rebuild the **DIT-1** drainage area for the new location, establish a time of concentration, apply land use areas and compute discharge.

The image shows two overlapping dialog boxes. The 'Drainage Area Definition' dialog box is in the background, showing the 'Definition' tab for Area ID DIT-1. It displays 'Drainage Area: 0.835', 'Base C Value: 0.350', and 'Time of Conc.: 5.872'. The 'Compute TC' button is highlighted. The 'Drainage Area Computations' dialog box is in the foreground, showing the 'Computation' tab for Area ID DIT-1. It displays a table of subarea data and a 'Compute Discharge' button.

	Area	C Value
Total Subareas:	0.834	0.300
Remainder:	0.001	0.350
Composite:	0.835	0.300

Hydro. Method: Rational (selected)  
Computed Intensity: 6.736  
Computed Discharge: 1.688

Click **Apply** to save the changes.



## Exercise 11

**Step 3.** Go to **Component > Node > Edit** and select Node DIT-2.

Under **Location**, change the station to **10+48** and the offset to **36.00**.

This is the point where we will achieve the 1 foot depth in our special ditch. At this location the ditch link will be a “V” ditch with 2:1 side slopes and is offset from the fill slope tie by 2 feet.

The dialog box shows the configuration for Node DIT-2. The 'Location' tab is selected in the left sidebar. The 'Chain' is set to 'CL' and the 'Profile' is 'DESIGNCL'. Under 'Coordinates / Stationing', 'Align' is 'Tangent to Chain' with an angle of 0.000. The 'Station' is 10+48.00, 'Offset' is 36.000, and the coordinates are X: 3605.606 and Y: 3032.211. The 'Offset from Gutter to Inlet' is 0.000. There are checkboxes for 'Window Center', 'Highlight', and 'Mirror Node'.

Click **Apply**.

**Step 4.** Use methods described previously to rebuild the **DIT-2** drainage area for the new location, establish a time of concentration, apply land use areas and compute discharge.

Remember ...ditch node drainage areas should include the area for the current node as well as any others previously defined that contribute to the ditch drainage network.

The image shows two overlapping dialog boxes. The 'Drainage Area Definition' dialog box on the left has 'Area ID' set to 'DIT-2'. The 'Definition' tab is selected, showing 'Drainage Area: 0.839', 'Base C Value: 0.350', and 'Time of Conc.: 5.266'. The 'Hydro. Method' is set to 'Rational'. The 'Drainage Area Computations' dialog box on the right also has 'Area ID' set to 'DIT-2'. The 'Computation' tab is selected, showing a table of area and C values.

	Area	C Value
Total Subareas:	0.832	0.300
Remainder:	0.007	0.350
Composite:	0.839	0.300
Computed Intensity:	6.906	
Computed Discharge:	1.740	

Click **Apply** to save the changes.

**Step 5.** Go to **Component > Node > Edit** and select Node DIT-3.

Under **Location**, change the station to **11+85** and the offset to **43.00**.

This is the beginning of the final ditch slope and to mitigate the steeper slope and resulting increase in velocity we will change the ditch link section to a 2 foot wide trapezoidal shape, 1 foot deep with 2:1 side slopes and is offset from the fill slope tie by 3 feet.

The dialog box shows the configuration for Node DIT-3. The 'Location' tab is selected in the left sidebar. The 'Chain' is set to 'CL' and the 'Profile' is 'DESIGNCL'. The 'Station' is '11+85.00' and the 'Offset' is '43.000'. The 'Coordinates / Stationing' section shows 'Align: Tangent to Chain' and '+ Angle: 0.000'. The 'X' coordinate is 3738.849 and the 'Y' coordinate is 2999.587. The 'Offset from Gutter to Inlet' is 0.000. The 'Apply' button is visible.

Click **Apply**.

**Step 6.** Use methods described previously to rebuild the **DIT-3** drainage area for the new location, establish a time of concentration, apply land use areas and compute discharge.

The image shows two overlapping dialog boxes. The 'Drainage Area Definition' dialog box is in the background, showing the 'Definition' tab for Area ID DIT-3. It displays 'Drainage Area: 0.381', 'Base C Value: 0.350', and 'Time of Conc.: 5.000'. The 'Hydro. Method' is set to 'Rational'. The 'Drainage Area Computations' dialog box is in the foreground, showing the 'Computation' tab for Area ID DIT-3. It displays a table of subarea computations and the final computed discharge.

Area	C Value
Total Subareas: 0.367	0.300
Remainder: 0.015	0.350
Composite: 0.381	0.302
Computed Intensity: 6.980	
Computed Discharge: 0.804	

Click **Apply** to save the changes.

## Exercise 11

**Step 7.** Go to **Component > Node > Edit** and select Node DIT-4.

Under **Location**, change the station to **13+28** and the offset to **72.00**.

This is the outlet for the special ditch and is shifted away from the fill slope tie to lead into the current existing drainage path.

The dialog box shows the configuration for Node DIT-4. The 'Location' tab is selected in the left sidebar. The 'Chain' is set to 'CL' and the 'Profile' is 'DESIGNCL'. The 'Coordinates / Stationing' section shows 'Align' as 'Tangent to Chain', 'Station' as '13+28.00', and 'Offset' as '72.000'. The 'X' coordinate is 3885.021 and the 'Y' coordinate is 2952.392. The 'Offset from Gutter to Inlet' is 0.000. The 'Apply' button is visible in the top right.

Click **Apply**.

**Step 8.** Use methods described previously to rebuild the **DIT-4** drainage area for the new location, establish a time of concentration, apply land use areas and compute discharge.

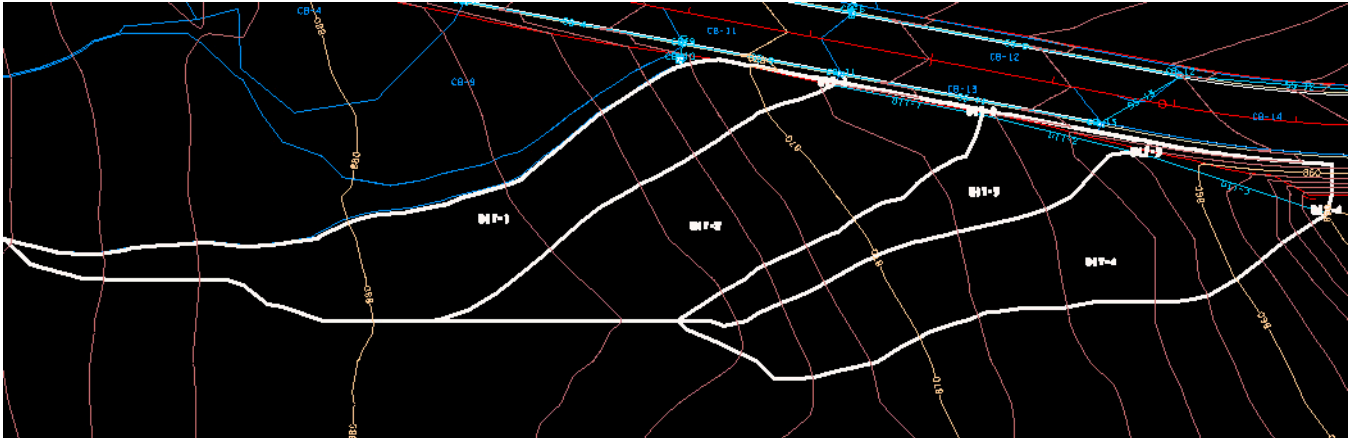
The image shows two overlapping dialog boxes. The 'Drainage Area Definition' dialog box on the left has the 'Area ID' set to 'DIT-4'. The 'Details' section shows 'Drainage Area' as 0.931, 'Base C Value' as 0.350, and 'Time of Conc.' as 5.000. The 'Hydro. Method' is set to 'Rational'. The 'Drainage Area Computations' dialog box on the right also has 'Area ID' set to 'DIT-4'. It shows a table of computations:

Area	C Value
Total Subareas: 0.885	0.325
Remainder: 0.046	0.350
Composite: 0.931	0.326
Computed Intensity: 6.980	
Computed Discharge: 2.117	

The 'Compute Discharge' button is visible in the top right of the 'Drainage Area Computations' dialog box.

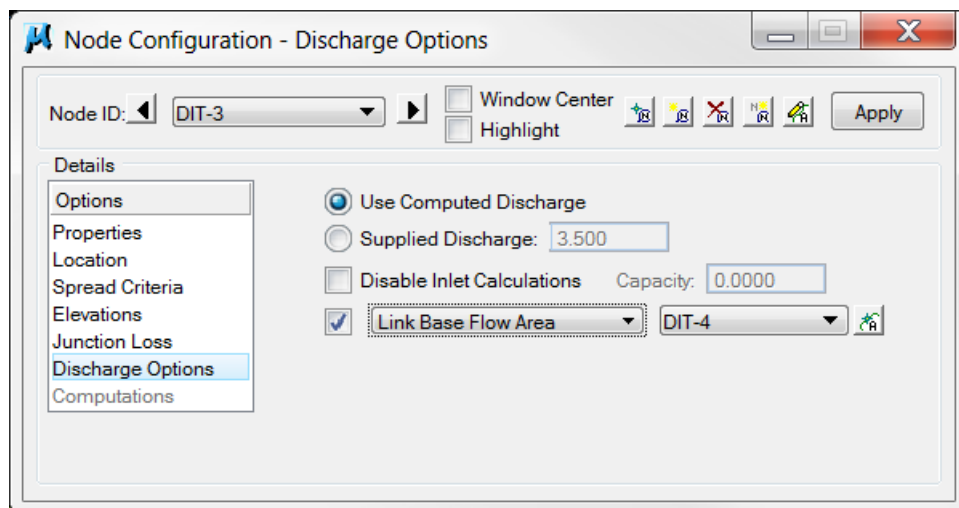
Click **Apply** to save the changes.

Final layout of revised ditch nodes and drainage areas.



**Step 9.** Since Node DIT-4 is an outlet type, it will not consider the drainage area developed for it. In order to ensure the final ditch link, DIT-3, will be adequate for the capacity at the end we will need to link the DIT-4 drainage area to it.

Go to **Component> Node> Edit** and select node DIT-3. Under Discharge Options click on the option to **Link Base Flow Area** and set to include the DIT-4 drainage area.



## Redefine Ditch Links with Fixed Geometry & Invert Elevations

**Step 1.** Go to **Component > Link > Edit** and select Link DIT-1.

Under **Definition**, make the following changes:

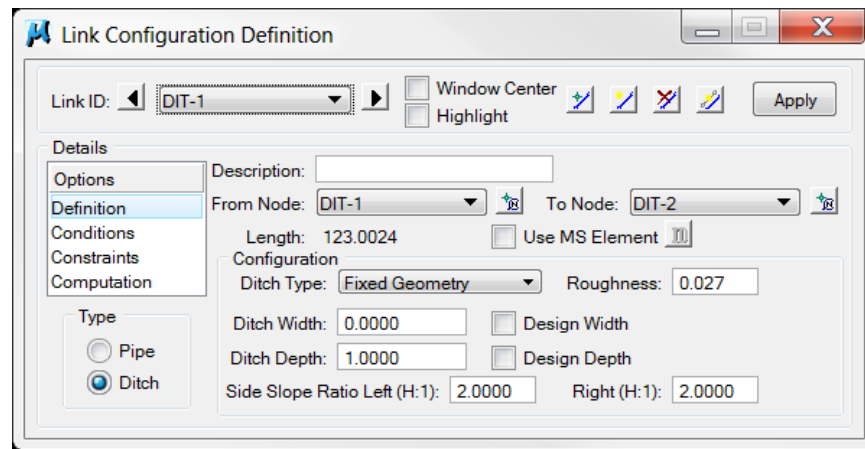
**Ditch Type:** Fixed Geometry

**Ditch Width:** 0 (Toggle OFF Design Width)

**Ditch Depth:** 1 (Toggle OFF Design Depth)

**Side Slope Ratio Left (H:1):** 2.00

**Side Slope Ratio Right (H:1):** 2.00



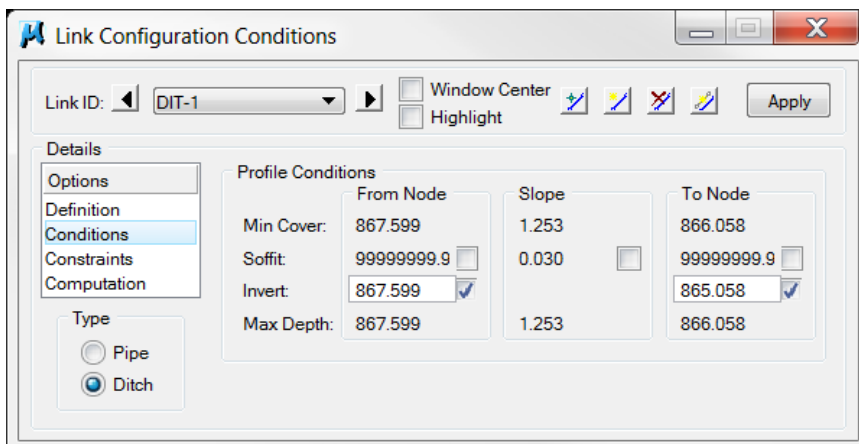
These settings define a “V” ditch at a 1’ depth with 2:1 side slopes.

**NOTE:** You can use the **Design Width** or **Design Depth** options individually but it is **not** recommended to use both at the same time. The software will always use the Minimum Rise value under **Constraints** for the depth and only adjusts the width if needed from that point.

**Step 2.** Under **Conditions**, make the following changes:

**From Node Invert:** 867.599 (existing ground elevation)

**To Node Invert:** 865.058 (1 foot below existing ground elevation)



These settings provide the transition from existing ground to the 1’ depth.

**NOTE:** The large numbers you may see specified for **Soffit** elevations can be ignored. These values are a result of the previous application of the Cross Section Based ditch type where these values are not applicable. When the ditch network is redesigned, the Soffit elevations will be recalculated.



**Step 3.** Under **Constraints**, make the following change:

**Minimum Rise:** 1.000 (to allow for defined 1 foot depth)

The dialog box shows the 'Constraints' tab selected in the left sidebar. The 'Design Constraints' table is as follows:

	Minimum	Maximum
Rise:	1.000	4.000
Slope:	0.400	11.000
Velocity:	3.000	12.000

The 'Type' section shows 'Ditch' selected with a radio button. The 'Apply' button is visible in the top right.

**Step 4.** Click **Apply** to save the changes to link DIT-1.

**Step 5.** In the **Link Configuration Definition** dialog go to Link DIT-2.  
Under **Definition**, make the following changes:

**Ditch Type:** Fixed Geometry

**Ditch Width:** 0 (Toggle OFF Design Width)

**Ditch Depth:** 1 (Toggle OFF Design Depth)

**Side Slope Ratio Left (H:1):** 2.00

**Side Slope Ratio Right (H:1):** 2.00

The dialog box shows the 'Definition' tab selected in the left sidebar. The 'Configuration' section is as follows:

Description:	
From Node:	DIT-2
To Node:	DIT-3
Length:	137.1787
<input type="checkbox"/> Use MS Element	
Ditch Type:	Fixed Geometry
Roughness:	0.027
Ditch Width:	0.0000
<input type="checkbox"/> Design Width	
Ditch Depth:	1.0000
<input type="checkbox"/> Design Depth	
Side Slope Ratio Left (H:1):	2.0000
Right (H:1):	2.0000

The 'Type' section shows 'Ditch' selected with a radio button. The 'Apply' button is visible in the top right.

These settings define a “V” ditch at a 1’ depth with 2:1 side slopes.

## Exercise 11

**Step 6.** Under **Conditions**, make the following changes:

**From Node Invert:** 865.058 (1 foot below existing ground elevation)

**To Node Invert:** 860.678 (1 foot below existing ground elevation)

The dialog box 'Link Configuration Conditions' for link 'DIT-2' shows the 'Conditions' tab selected. The 'Type' is set to 'Ditch'. The 'Profile Conditions' section is configured as follows:

	From Node	Slope	To Node
Min Cover:	866.058	3.193	861.678
Soffit:	99999999.9	0.015	99999999.9
Invert:	865.058		860.678
Max Depth:	866.058	3.193	861.678

These settings maintain the 1' depth below the existing ground.

**Step 7.** Under **Constraints**, make the following change:

**Minimum Rise:** 1.000 (to allow for defined 1 foot depth)

The dialog box 'Link Configuration Constraints' for link 'DIT-2' shows the 'Constraints' tab selected. The 'Type' is set to 'Ditch'. The 'Design Constraints' section is configured as follows:

	Minimum	Maximum
Rise:	1.000	4.000
Slope:	0.400	11.000
Velocity:	3.000	12.000

**Step 8.** Click **Apply** to save the changes to link DIT-2.

**Step 9.** In the **Link Configuration Definition** dialog go to Link DIT-3.  
Under **Definition**, make the following changes:

**Ditch Type:** Fixed Geometry

**Ditch Width:** 2 (Toggle OFF Design Width)

**Ditch Depth:** 1 (Toggle OFF Design Depth)

**Side Slope Ratio Left (H:1):** 2.00

**Side Slope Ratio Right (H:1):** 2.00

Link Configuration Definition

Link ID: DIT-3

Window Center Highlight

Apply

Details

Options

Definition

Conditions

Constraints

Computation

Type

Pipe

Ditch

Description:

From Node: DIT-3 To Node: DIT-4

Length: 153.6017 Use MS Element

Configuration

Ditch Type: Fixed Geometry Roughness: 0.027

Ditch Width: 2.0000 Design Width

Ditch Depth: 1.0000 Design Depth

Side Slope Ratio Left (H:1): 2.0000 Right (H:1): 2.0000

These settings define a 2' wide trapezoidal (flat bottom) ditch at a 1' depth with 2:1 side slopes.

**Step 10.** Under **Conditions**, make the following changes:

**From Node Invert:** 860.678 (1 foot below existing ground elevation)

**To Node Invert:** 850.037 (existing ground elevation)

Link Configuration Conditions

Link ID: DIT-3

Window Center Highlight

Apply

Details

Options

Definition

Conditions

Constraints

Computation

Type

Pipe

Ditch

Profile Conditions

	From Node	Slope	To Node
Min Cover:	861.678	7.579	850.037
Soffit:	99999999.9	0.062	99999999.9
Invert:	860.678		850.037
Max Depth:	861.678	7.579	850.037

These settings provide the transition from the 1' depth back to the existing ground elevation at the end of the ditch.

## Exercise 11

**Step 11.** Under **Constraints**, make the following change:

**Minimum Rise:** 1.000 (to allow for defined 1 foot depth)

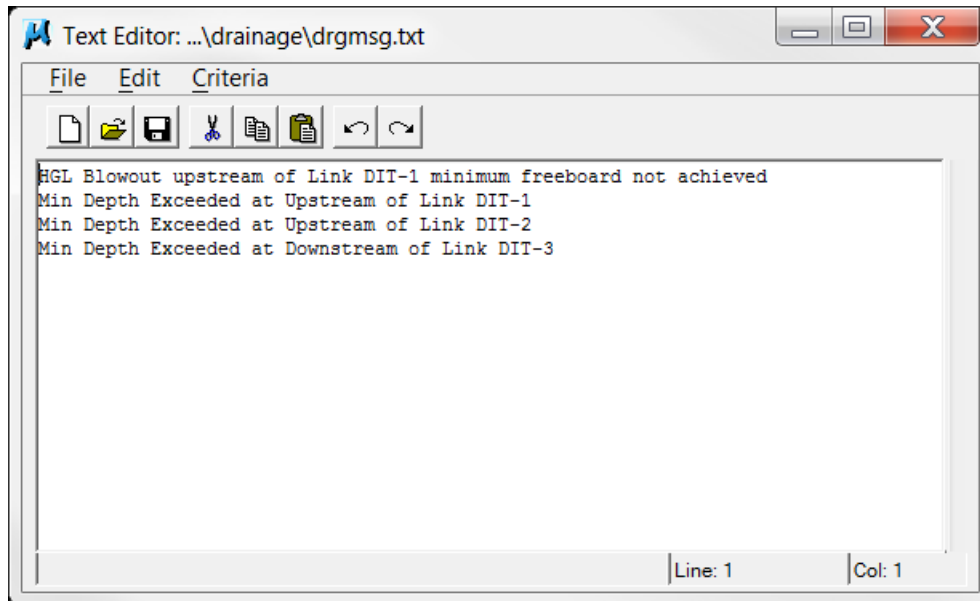
The screenshot shows the 'Link Configuration Constraints' dialog box. At the top, the 'Link ID' is set to 'DIT-3'. There are checkboxes for 'Window Center' and 'Highlight', both of which are unchecked. To the right of these checkboxes are four small icons: a blue line with a green arrow, a yellow line with a green arrow, a red line with a green arrow, and a blue line with a green arrow. An 'Apply' button is located to the right of these icons. Below the 'Link ID' field is a 'Details' section with a list of options: 'Options', 'Definition', 'Conditions', 'Constraints' (which is selected and highlighted in blue), and 'Computation'. To the right of the 'Details' list is a 'Design Constraints' table. The table has three columns: 'Design Constraints', 'Minimum', and 'Maximum'. The rows are 'Rise', 'Slope', and 'Velocity'. The values are: Rise: 1.000 (Minimum) and 4.000 (Maximum); Slope: 0.400 (Minimum) and 11.000 (Maximum); Velocity: 3.000 (Minimum) and 12.000 (Maximum). Below the 'Design Constraints' table is a 'Type' section with two radio buttons: 'Pipe' and 'Ditch'. The 'Ditch' radio button is selected.

Design Constraints	Minimum	Maximum
Rise:	1.000	4.000
Slope:	0.400	11.000
Velocity:	3.000	12.000

**Step 12.** Click **Apply** to save the changes to link DIT-3.

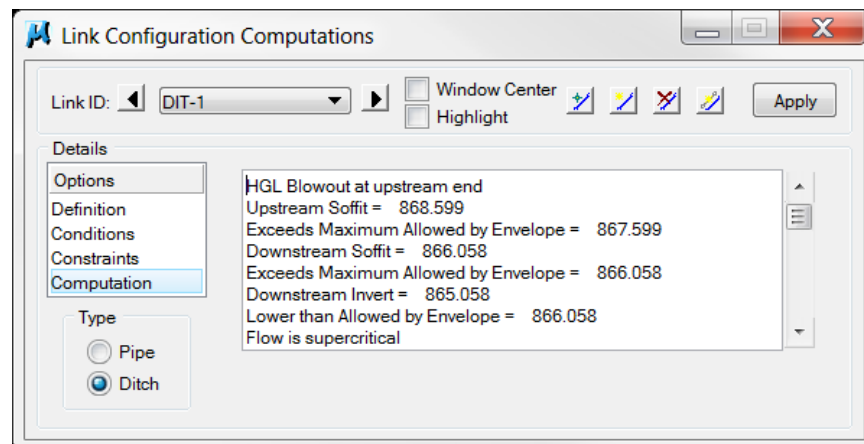
## Redesign Ditch Network & Review

- Step 1.** Go to **Network > Active Network** and select WEST DIT.
- Step 2.** Go to **Network > Design**.
- Step 3.** Review any errors that are generated by the redesign of the network and close the text editor. (See **Appendix C** for common errors and fixes)



- Step 4.** Review computation results.

Go to **Component > Link > Edit** and review the link computations for links DIT-1, DIT-2 & DIT-3.





# Exercise 11

Go to **Reports> Storm Drains\Links> Link Hydraulic Computations.**

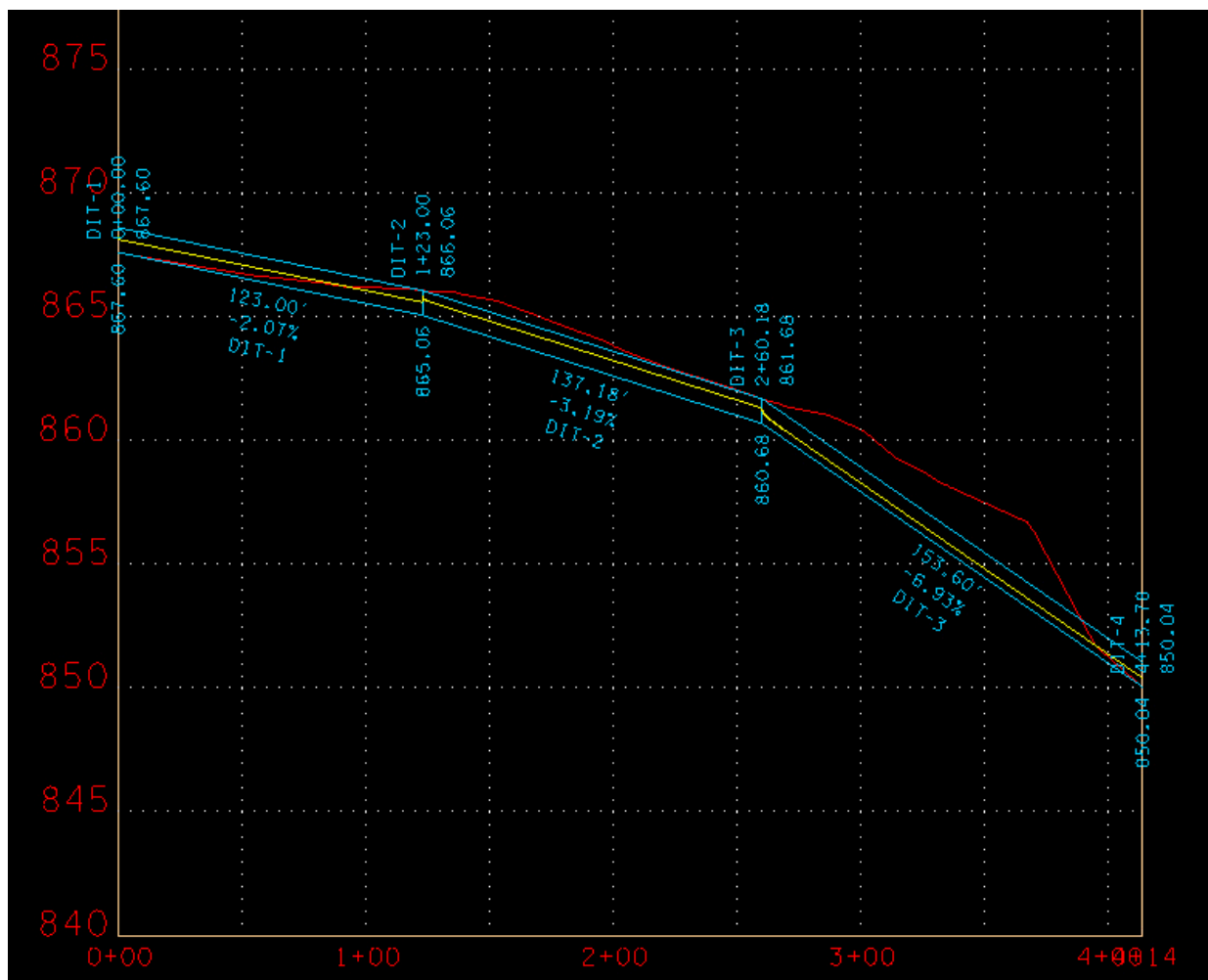
Storm Drain Hydraulic Calculation Summary for Network WEST DIT - Calculations Current

ID	Upstream ID	Downstream ID	Upstream HGL	Downstream HGL	Discharge	Capacity	Slope	Loss	Uniform Velocity	Actual Velocity	Uniform Depth	Actual Depth
DIT-3	DIT-3	DIT-4	861.234	850.395	5.888	42.042	6.926	0.020	6.053	6.053	0.358	0.358
DIT-2	DIT-2	DIT-3	865.807	861.303	3.289	11.502	3.203	0.049	4.211	4.211	0.625	0.625
DIT-1	DIT-1	DIT-2	868.269	865.586	1.688	9.252	2.066	0.134	3.023	3.023	0.528	0.528

ASCII File:   ☐ Window Center ☐ Highlight

**Step 5.** Zoom in on the ditch profile graphics.

The profile has been automatically updated and reflects our new proposed ditch definitions.



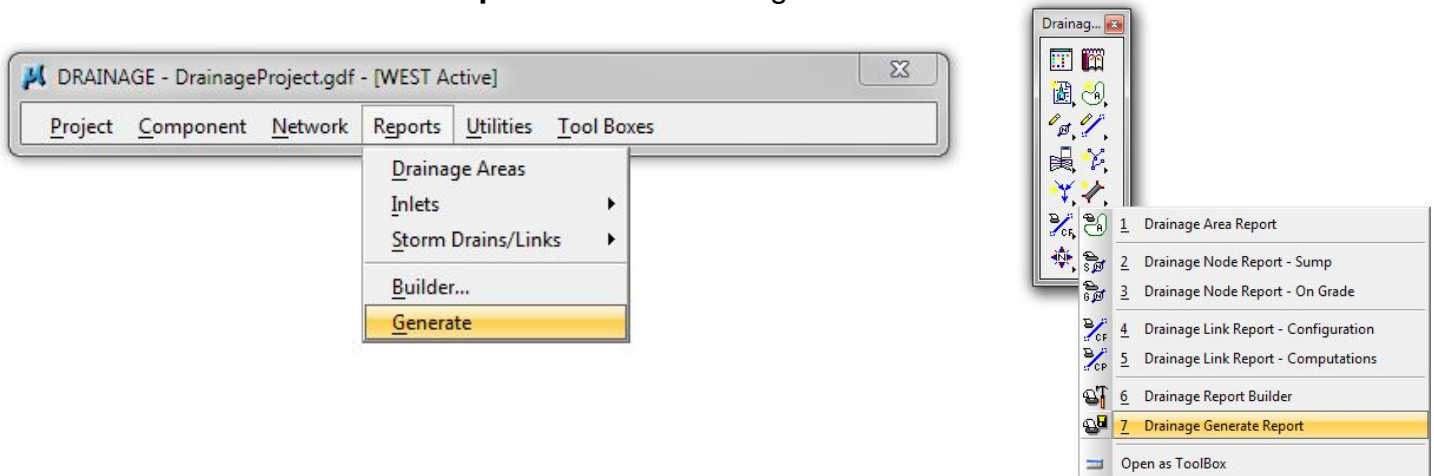


# Reports

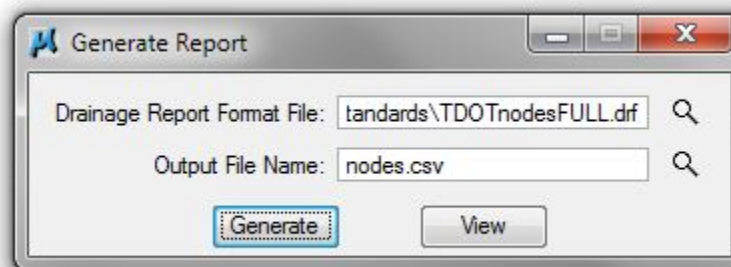
This exercise shows the user the report options by creating standard and customized reports.

## 12.1 Create Customized Reports

**Step 1.** Select **Reports > Generate** from the Drainage Menu Bar or **Drainage Generate Report** from the Drainage Toolbar:



**Step 2.** Use the browse button to select report format file **TDOTnodesFULL.drf** (from C:\Users\Public\Geopak Standards\). Click in the Output File Name area and type in **nodes.csv** as the file name. Click **Generate** to create the report file.



**Step 3.** Use Excel to open and review **nodes.csv** report file.

**Step 4.** Access report format **TDOTlinksFULL.drf** and generate **links.csv** report file.

**Step 5.** Use Excel to open and review **links.csv** report file.

## 12.2 Excel Tab Builder

- Step 1.** Open Excel and click **File > New**
- Step 2.** Click **My templates > TDOT English Tab Quantities > Storm Drainage Structure Tab Builder**
- Step 3.** Click **Build Catch Basins and Manholes Block.**
- Step 4.** Navigate to the project folder, select the file **nodes.csv** created in Exercise 12.1 and click open. The tab block is created.

CATCH BASINS														
SHEET NO.	LOCATION	STATION	OFFSET (FT.)	DRAINAGE CODE	GRATE/TOP ELEV.	STRUCTURE TYPE	INSIDE DIMENSION	DEPTH (FT.)	STANDARD DRAWINGS	TYPE 12 C.B. 611-12.01 0' - 4'	TYPE 12 C.B. 611-12.02 4' - 8'	TYPE 42 C.B. 611-42.01 0' - 4'	TYPE 43 C.B. 611-43.02 4' - 8'	REMARKS
	CL	11+45.00	26	CB-13	865.16	#12	4X3	4.59			1			
	CL	12+00.00	-26	CB-12	863.9	#12	4X3	5.9			1			
	CL	14+00.00	-26	CB-14	860.14	#12	4X3	6.64			1			
	CL	3+70.00	-26	CB-1	880.97	#12	4X3	3.88		1				
	CL	3+70.00	26	CB-2	880.95	#12	4X3	4.05			1			
	CL	3+70.00	35	CB-5	881.51	#42	4X4	3.8				1		
	CL	6+20.00	-26	CB-3	874.68	#12	4X3	5.24			1			
	CL	6+20.00	26	CB-4	874.66	#12	4X3	3.88		1				
	CL	6+20.00	-50	CB-7	874.11	#43	8X4	4.42					1	
	CL	8+00.00	26	CB-9	870.78	#12	4X3	4.21			1			
	CL	8+00.00	38	CB-10	872.38	#43	8' DIA	4.49					1	
	CL	9+30.00	-26	CB-6	868.55	#12	4X3	4.42			1			
	CL	9+30.00	-35	CB-8	869.19	#42	4X4	3.8				1		
	CL	9+30.00	26	CB-11	868.52	#12	4X3	4.38			1			
TOTALS										2	8	2	2	

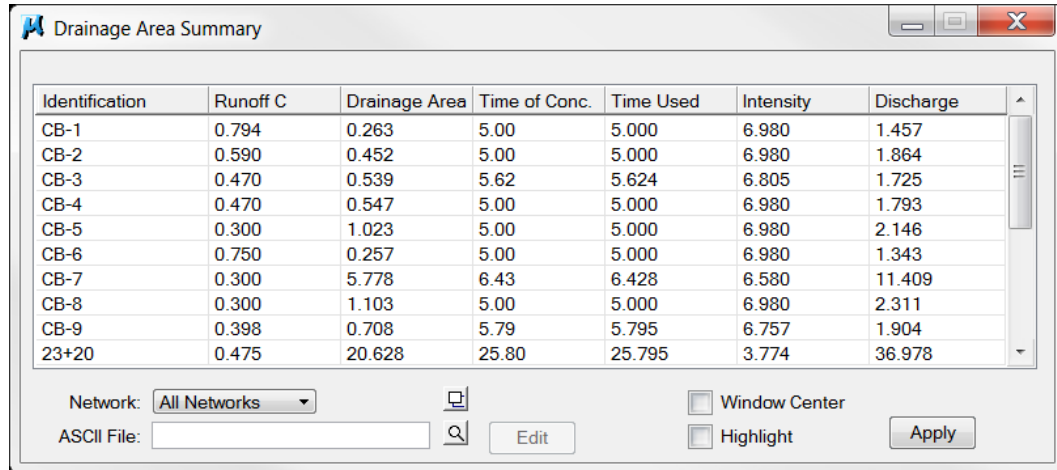
- Step 5.** Repeat Step 1 through Step 4 using the **links.csv** file and the **Storm Drainage Pipe Tab Builder**

STORM DRAINAGE PIPES									
SHEET NO.	FROM		TO		% GRADE	RCP CLASS III			
	CODE	OUTLET ELEV.	CODE	INLET ELEV.		607-03.02	607-05.02	607-06.02	607-07.02
						18" (L.F.)	24" (L.F.)	30" (L.F.)	36" (L.F.)
	CB-1	877.09	CB-3	870.93	2.50	246			
	CB-2	876.90	CB-4	870.95	2.42	246			
	CB-3	869.44	CB-6	864.30	1.68		306		
	CB-4	870.78	CB-9	867.07	2.11	176			
	CB-5	877.71	CB-2	877.07	9.82	6			
	CB-6	864.13	CB-12	859.65	1.68		266		
	CB-7	869.69	CB-3	869.61	0.40		19		
	CB-8	865.39	CB-6	864.80	9.13	6			
	CB-9	866.57	CB-11	864.31	1.79		126		
	CB-10	867.89	CB-9	867.07	11.00	7			
	CB-11	864.14	CB-13	860.74	1.61		211		
	CB-12	858.00	CB-14	854.00	2.10			191	
	CB-13	860.57	CB-12	859.65	1.27		72		
	CB-14	853.50	EW-1	850.42	4.18				74
TOTALS						688	1000	191	74

## 12.3 Standard Reports

Geopak Drainage also provides several standard reports which are useful during storm drainage network design. The current Active Network will determine which drainage features are listed.

**Step 1.** Select **Reports > Drainage Areas** from the Drainage Menu Bar.

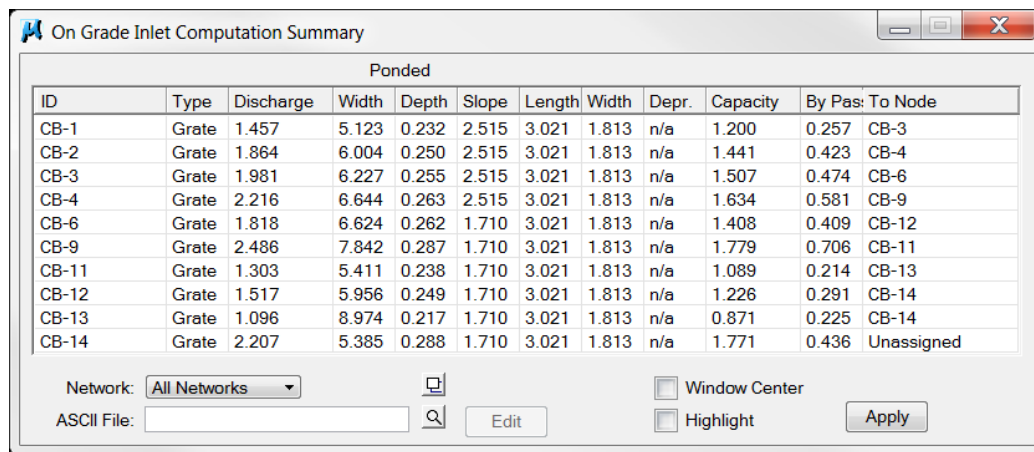


Drainage Area Summary

Identification	Runoff C	Drainage Area	Time of Conc.	Time Used	Intensity	Discharge
CB-1	0.794	0.263	5.00	5.000	6.980	1.457
CB-2	0.590	0.452	5.00	5.000	6.980	1.864
CB-3	0.470	0.539	5.62	5.624	6.805	1.725
CB-4	0.470	0.547	5.00	5.000	6.980	1.793
CB-5	0.300	1.023	5.00	5.000	6.980	2.146
CB-6	0.750	0.257	5.00	5.000	6.980	1.343
CB-7	0.300	5.778	6.43	6.428	6.580	11.409
CB-8	0.300	1.103	5.00	5.000	6.980	2.311
CB-9	0.398	0.708	5.79	5.795	6.757	1.904
23+20	0.475	20.628	25.80	25.795	3.774	36.978

Network: All Networks ☐ Window Center  
 ASCII File:  ☐ Highlight

**Step 2.** Select **Reports > Inlets> On Grade Inlets** from the Drainage Menu Bar.



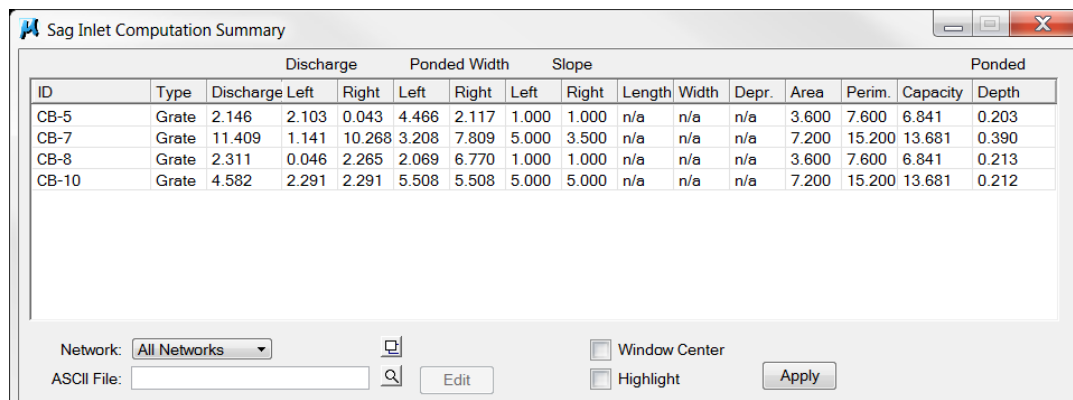
On Grade Inlet Computation Summary

Ponded

ID	Type	Discharge	Width	Depth	Slope	Length	Width	Depr.	Capacity	By Pas:	To Node
CB-1	Grate	1.457	5.123	0.232	2.515	3.021	1.813	n/a	1.200	0.257	CB-3
CB-2	Grate	1.864	6.004	0.250	2.515	3.021	1.813	n/a	1.441	0.423	CB-4
CB-3	Grate	1.981	6.227	0.255	2.515	3.021	1.813	n/a	1.507	0.474	CB-6
CB-4	Grate	2.216	6.644	0.263	2.515	3.021	1.813	n/a	1.634	0.581	CB-9
CB-6	Grate	1.818	6.624	0.262	1.710	3.021	1.813	n/a	1.408	0.409	CB-12
CB-9	Grate	2.486	7.842	0.287	1.710	3.021	1.813	n/a	1.779	0.706	CB-11
CB-11	Grate	1.303	5.411	0.238	1.710	3.021	1.813	n/a	1.089	0.214	CB-13
CB-12	Grate	1.517	5.956	0.249	1.710	3.021	1.813	n/a	1.226	0.291	CB-14
CB-13	Grate	1.096	8.974	0.217	1.710	3.021	1.813	n/a	0.871	0.225	CB-14
CB-14	Grate	2.207	5.385	0.288	1.710	3.021	1.813	n/a	1.771	0.436	Unassigned

Network: All Networks ☐ Window Center  
 ASCII File:  ☐ Highlight

### Sag Inlets



Sag Inlet Computation Summary

ID	Type	Discharge		Ponded Width		Slope		Length	Width	Depr.	Area	Perim.	Capacity	Ponded Depth
		Left	Right	Left	Right	Left	Right							
CB-5	Grate	2.146	2.103	0.043	4.466	2.117	1.000	1.000	n/a	n/a	3.600	7.600	6.841	0.203
CB-7	Grate	11.409	1.141	10.268	3.208	7.809	5.000	3.500	n/a	n/a	7.200	15.200	13.681	0.390
CB-8	Grate	2.311	0.046	2.265	2.069	6.770	1.000	1.000	n/a	n/a	3.600	7.600	6.841	0.213
CB-10	Grate	4.582	2.291	2.291	5.508	5.508	5.000	5.000	n/a	n/a	7.200	15.200	13.681	0.212

Network: All Networks ☐ Window Center  
 ASCII File:  ☐ Highlight



**Step 3. Select Reports > Storm Drains/Links> Link Configuration from the Drainage Menu Bar.**

Storm Drain Configuration Summary for Network WEST - Calculations Current

Upstream		Downstream									Upstream		Downstream	
ID	ID	ID	Discharge	Length	Shape	#	Rise	Span	n	Slope	Invert	Invert		
SS-14	CB-14	EW-1	31.612	73.540	Circ...	1	3.000	n/a	0.013	4.182	853.500	850.425		
SS-12	CB-12	CB-14	30.494	190...	Circ...	1	2.500	n/a	0.013	2.098	858.000	854.000		
SS-6	CB-6	CB-12	17.408	265...	Circ...	1	2.000	n/a	0.013	1.684	864.128	859.652		
SS-13	CB-13	CB-12	12.726	72.257	Circ...	1	2.000	n/a	0.013	1.270	860.569	859.652		
SS-3	CB-3	CB-6	14.399	306...	Circ...	1	2.000	n/a	0.013	1.681	869.443	864.298		
SS-8	CB-8	CB-6	2.311	6.460	Circ...	1	1.500	n/a	0.013	9.127	865.388	864.798		
SS-11	CB-11	CB-13	12.156	211...	Circ...	1	2.000	n/a	0.013	1.611	864.138	860.739		
SS-1	CB-1	CB-3	1.457	246...	Circ...	1	1.500	n/a	0.013	2.503	877.090	870.931		
SS-7	CB-7	CB-3	11.409	19.460	Circ...	1	2.000	n/a	0.013	0.400	869.691	869.613		
SS-9	CB-9	CB-11	11.735	126...	Circ...	1	2.000	n/a	0.013	1.795	866.570	864.308		

ASCII File:   ☐ Window Center ☐ Highlight

## Link Hydraulic Calculations

Storm Drain Hydraulic Calculation Summary for Network WEST - Calculations Current

Upstream		Downstream		Upstream		Downstream		Uniform				Actual	
ID	ID	ID	HGL	HGL	Discharge	Capacity	Slope	Loss	Velocity	Depth	Velocity	Depth	
SS-14	CB-14	EW-1	856.237	851.489	31.612	146.718	4.181	0.851	15.703	0.982	14.069	1.065	
SS-12	CB-12	CB-14	861.997	855.280	30.494	63.904	2.097	2.031	12.181	1.270	12.052	1.280	
SS-6	CB-6	CB-12	866.140	860.760	17.408	31.583	1.689	0.440	9.752	1.107	9.736	1.109	
SS-13	CB-13	CB-12	862.211	861.997	12.726	27.419	1.277	0.141	8.129	0.997	4.051	2.000	
SS-3	CB-3	CB-6	872.281	865.288	14.399	31.554	1.677	1.404	9.285	0.990	9.285	0.990	
SS-8	CB-8	CB-6	866.351	865.120	2.311	34.138	9.125	0.069	10.461	0.274	8.311	0.322	
SS-11	CB-11	CB-13	865.466	861.648	12.156	30.889	1.604	0.010	8.746	0.909	8.746	0.909	
SS-1	CB-1	CB-3	877.737	871.232	1.457	17.878	2.504	0.094	5.787	0.300	5.787	0.300	
SS-7	CB-7	CB-3	872.550	872.281	11.409	15.391	0.400	0.205	5.059	1.349	3.632	2.000	
SS-9	CB-9	CB-11	869.185	865.178	11.735	32.600	1.797	1.313	9.036	0.864	8.959	0.869	

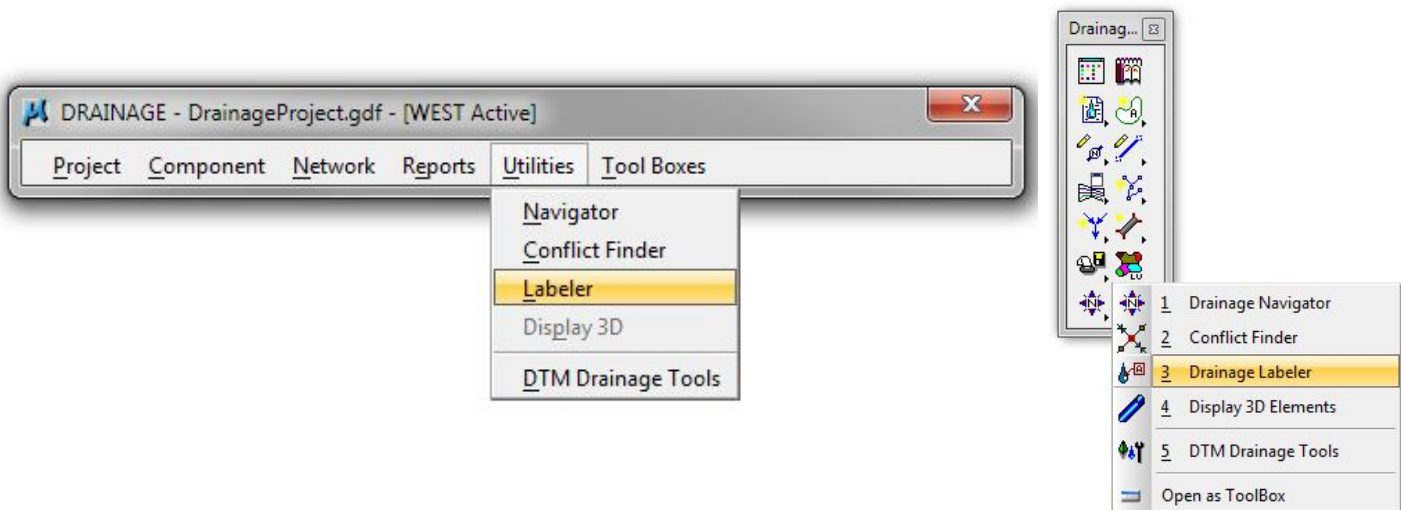
ASCII File:   ☐ Window Center ☐ Highlight

## Storm Drainage Labeling

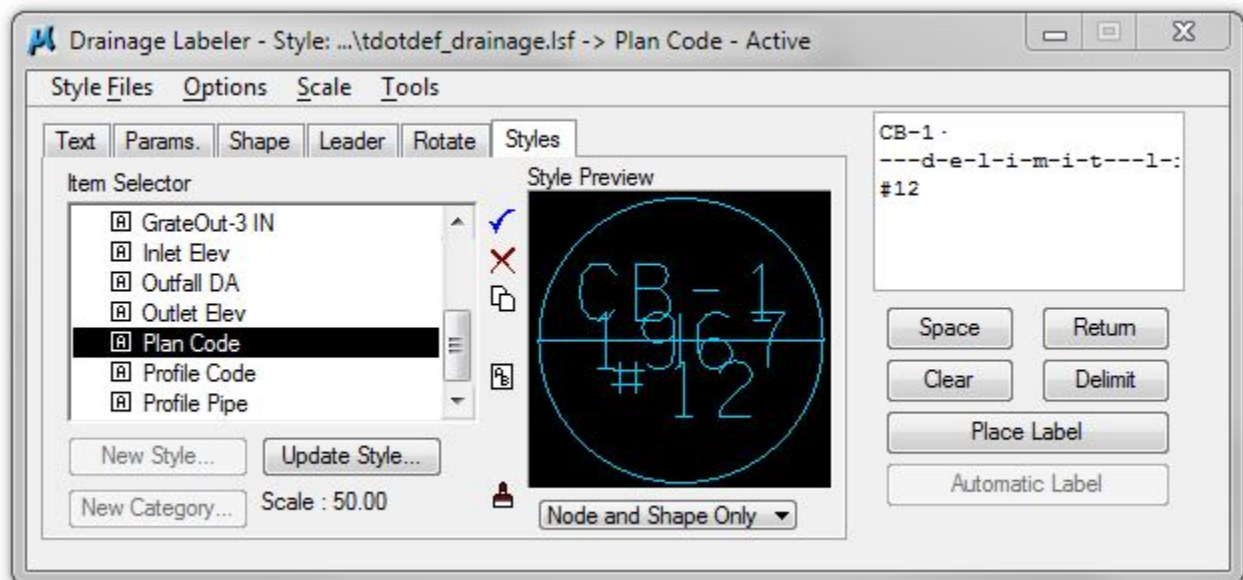
This exercise shows the user how to use standard labels by labeling the plan and profile views. The Labeler automates the composition and placement of many types of labels into the dgn file. This interactive tool permits the creation of very simple to very complex labels.

### 13.1 Plan View Labeling

- Step 1.** Open the Drainage Labeler by selecting **Utilities > Labeler** from the pull down menu or **Drainage Labeler** from the Drainage Toolbar.

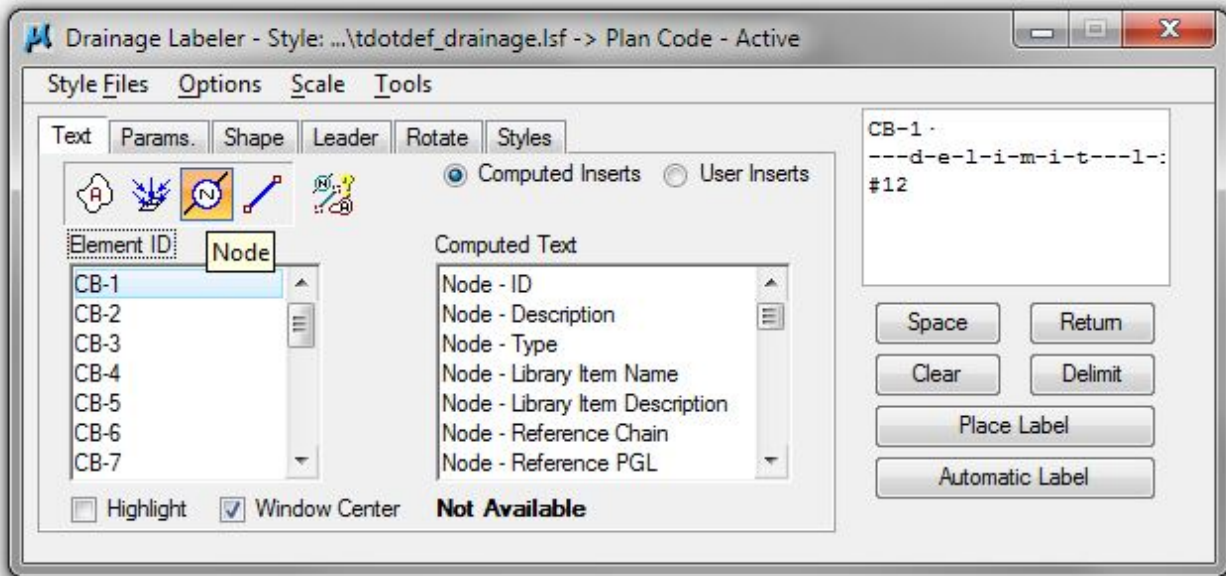


- Step 2.** Click on the **Style** tab, select **Plan Code** under the Storm Drainage category and double click it to make it the active style.

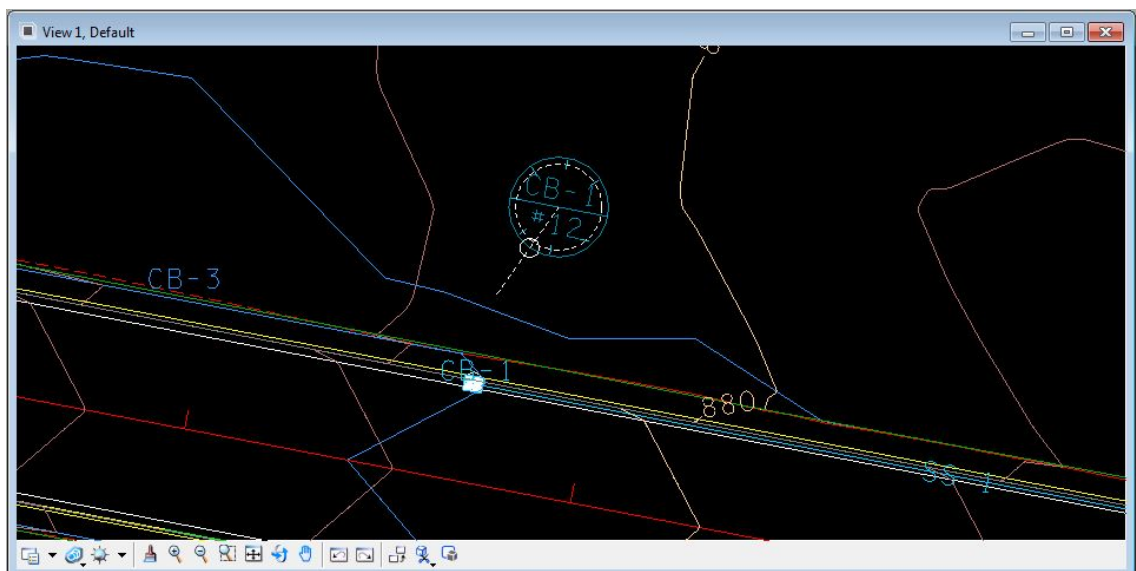


- Step 3.** Zoom in to CB-1 in plan view.

- Step 4.** Click on the **Text** tab, then click the **Nodes** icon and toggle **ON Window Center**.
- Step 5.** Click on **CB-1** from the node list. Label data is automatically set for that node and view centers at node location.



- Step 6.** Select from the pulldown menu: **Scale > Change Scale** and change to **50**.
- Step 7.** Click the **Place Label** button on the right of dialog to initiate placement of the label.
- Step 8.** Move the cursor to position the label and **data point** to place the label in the vicinity of CB-1. If the label text is not horizontal to the view or alignment, you may need to go to the **Rotate** tab to set the angle prior to placement.
- Step 9.** Move the cursor around and **data point** once again to locate the leader line point of beginning (i.e. where you want the leader to connect to the label).



## Exercise 13

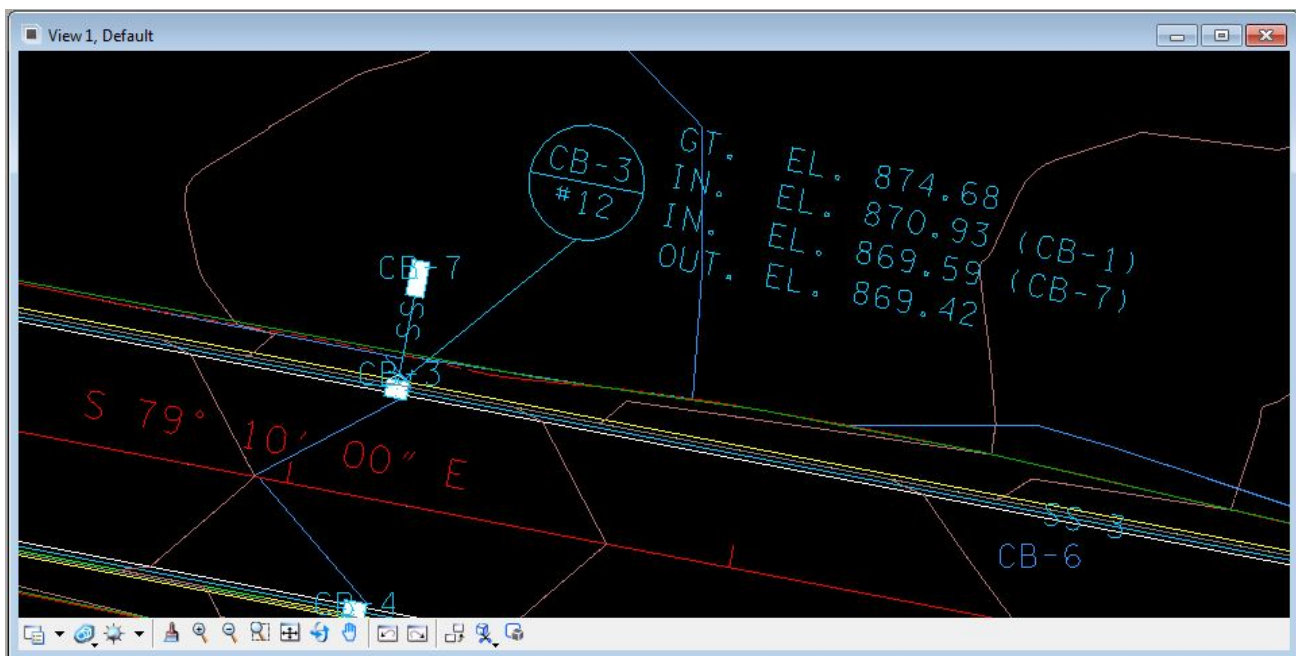
**Step 10.** Click the **Style** tab and set the active style to **GrateOut-01N** with a double click.

**Step 11.** Click the **Text** tab and select **CB-1**. Click **Place Label** and data point next to the Code Label to position the text.

**NOTE:** For catch basins with one or more inlets, elevation labels will require an extra step to insert the inlet elevation(s).

**Step 12.** Place labels for CB-3 which includes 2 inlet pipes.

- a. Click the **Style** tab and set the active style to **GrateOut-2IN** with a double click.
- b. Click the **Text** tab and select **CB-3**. Click **Place Label** and data point next to the Code Label to position the text.
- c. Click the **Style** tab and set the active style to **Inlet Elev** with a double click.
- d. Click the **Text** tab and select **SS-1**. Click **Place Label** and data point below the **GT. EL.** Text placed in step **b**.
- e. Select **SS-7**. Click **Place Label** and data point below the **IN. EL.** Text placed in step **d**.



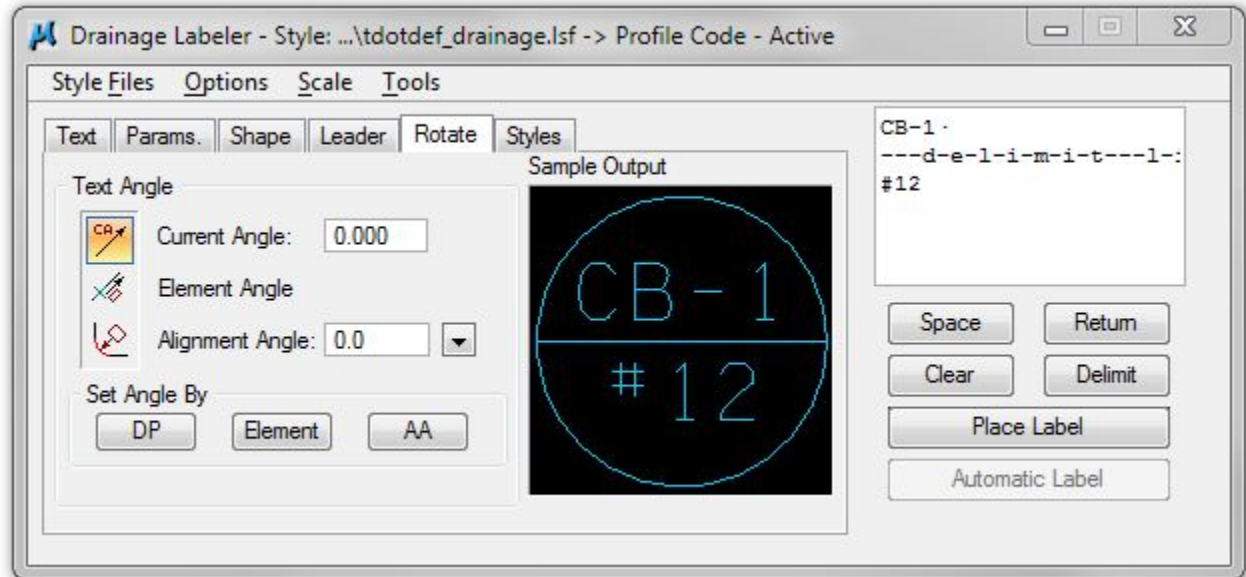
**Step 13.** Place the remaining plan view Node labels.

## 13.2 Profile View Labeling

Normally the plan view displays most of the data for a catch basin, however, in some circumstance labels on the profile may be required.

**Step 1.** Click on the **Styles** tab and double click on the style **Profile Code** to activate it.

**Step 2.** Click on the **Rotate** tab and click on **Current Angle** (If needed set to 0)



**Step 3.** Click on the **Text** tab and toggle OFF the **Window Center Box**. This option works with plan view only.

**Step 4.** Zoom in on the alignment profile view in the vicinity of CB-1.

**Step 5.** Click on CB-1 in the node list and then click **Place Label**.

**Step 6.** Locate in profile view and place the label.

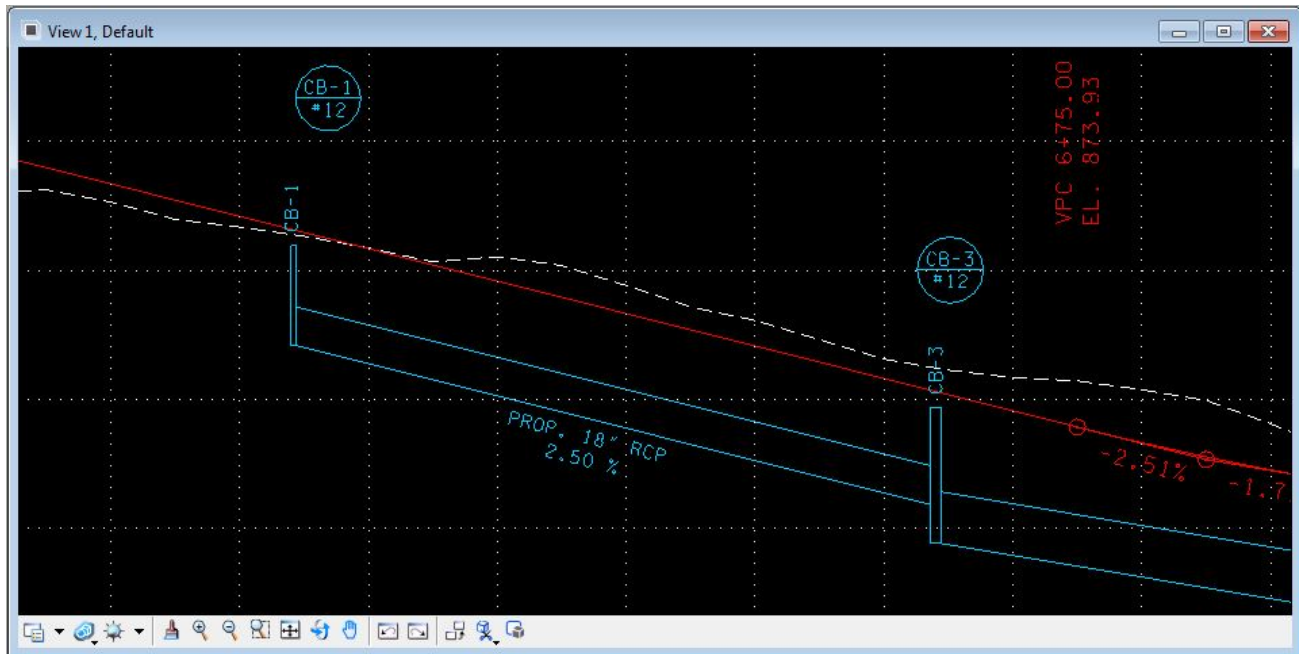
**Step 7.** Repeat until all codes are placed for all nodes in the profile view.



## Leader Line Optional Steps:

**Step 8.** Use MicroStation's **Match Element Attributes** and click on any code placement.

**Step 9.** Use MicroStation's **Place Line** to place leader lines from code placement to node.



## NOTE:

Pipes are automatically annotated correctly for the plans when the preference file **TDOTStormSewerProfiles-Plan.ppf** is used for profile display control. When using label style **Profile pipe** to label proposed pipes on the profile ...

Select the link under the **Text** tab

Go to the **Rotate** tab and set to **Element Angle**

Click **Element** button in the *Set Angle By* portion of the dialog and identify the bottom of pipe on the profile to set label angle.

Data point to place label.

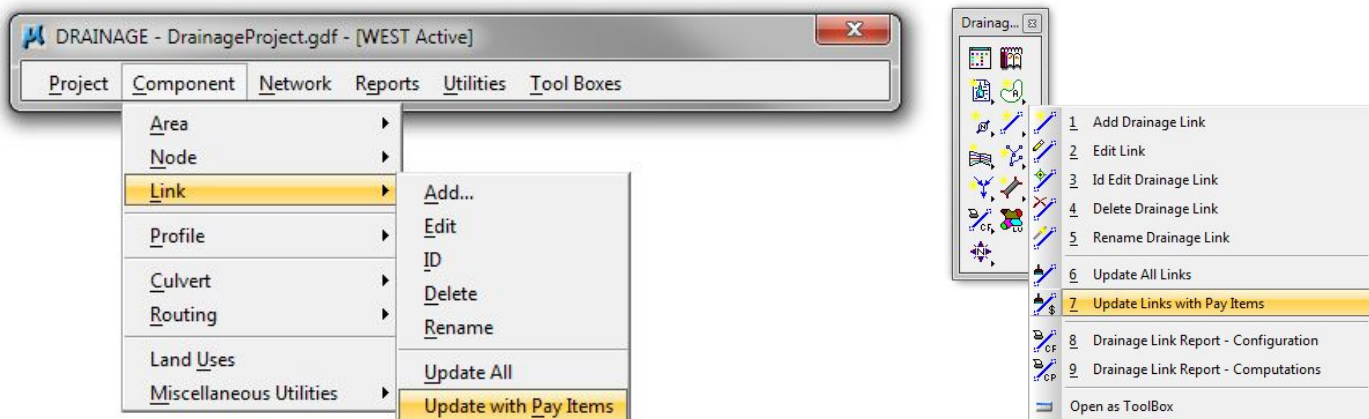


# Design & Computation Manager with Drainage Links

This exercise shows the user how to use the D&C Manager to control symbology, compute quantities, which can be used in preliminary estimates, and set pay items for drainage links by setting the symbology of all pipes and generating pipe quantities for this project.

## 14.1 Set Link Symbology

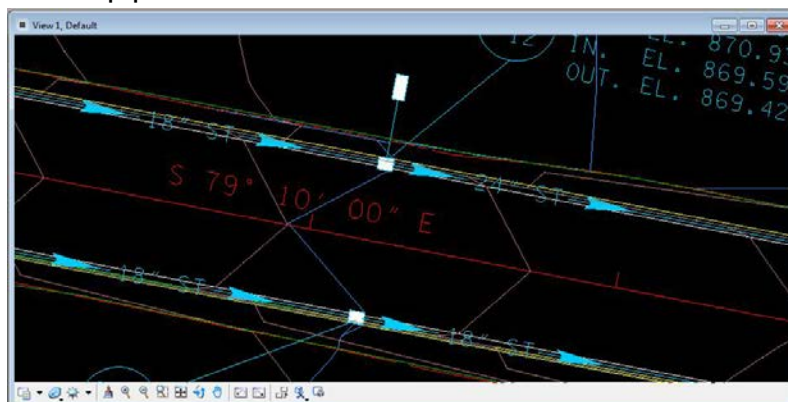
**Step 1.** Select **Components > Links > Update With Pay Items** from the main menu bar or **Update Links with Pay Items** from the Drainage Toolbox.



**Step 2.** Utilize the MicroStation command **Fit View** to view the entire Drainage Network.



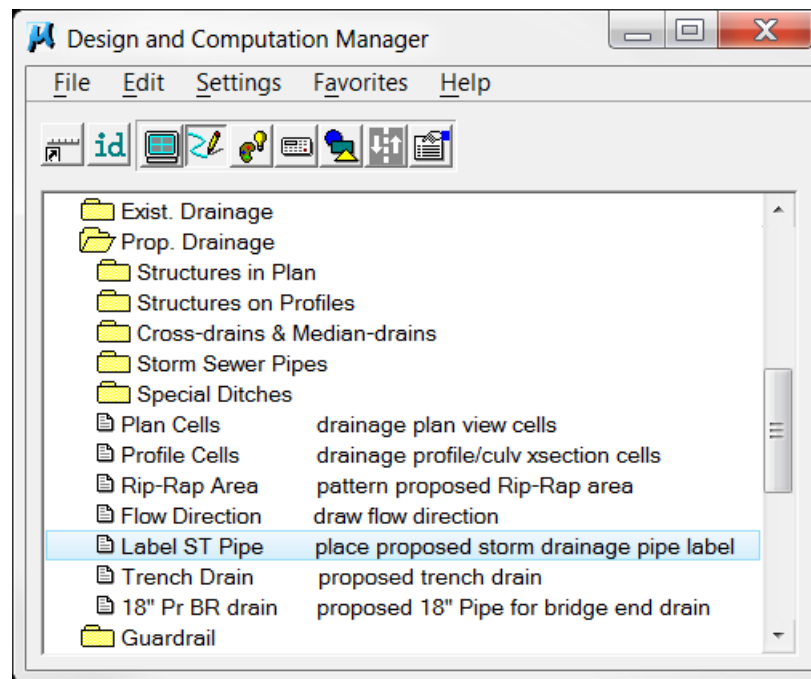
**Step 3.** Note that the Link symbology has changed to reflect that of the D&C Manager. All links use appropriate custom line styles and are labeled with ST's and pipe size.



## 14.2 Label Short Pipe Links

Often we have cases where the pipes are too short for their symbol to show as is the case with the pipes from various drop inlets just off the roadway in this project. We have a tool available to handle these with a separate label which is available through D&C Manager.

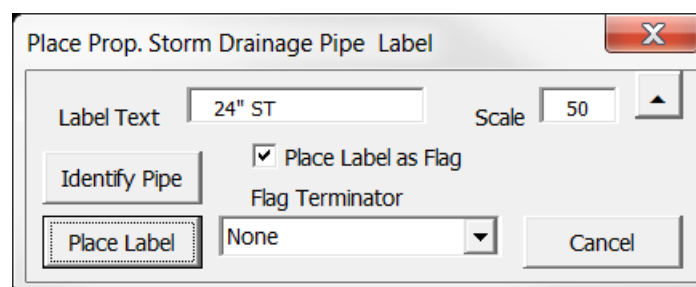
**Step 1.** Open the Design and Computation Manager and select item **Drafting Standards> Prop. Drainage> Label ST Pipe**.



**Step 2.** The **Place Prop. Storm Drainage Pipe Label** dialog opens and you are prompted to identify the pipe. Data point on link SS-7, the pipe between CB-7 and CB-3, and the appropriate text is filled in on the dialog.

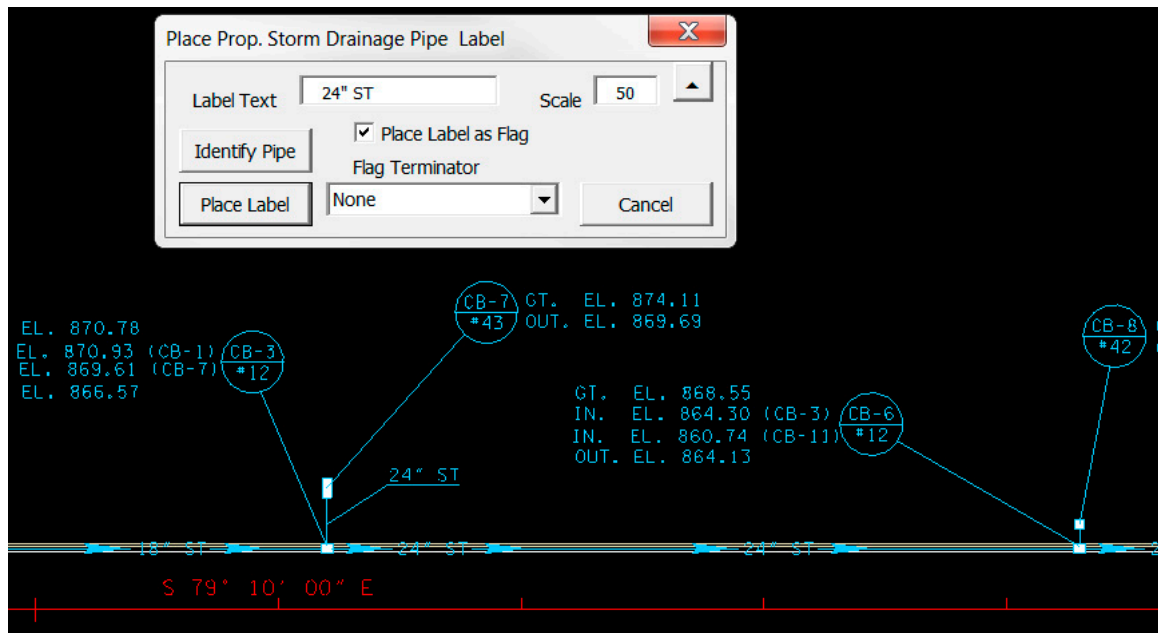
By default the label will come up as text only at the angle of the pipe. If there is room, you can place the bale as such along the pipe.

For pipes too short for that, click on the option to **Place Label as Flag** and click the **Place Label** button.



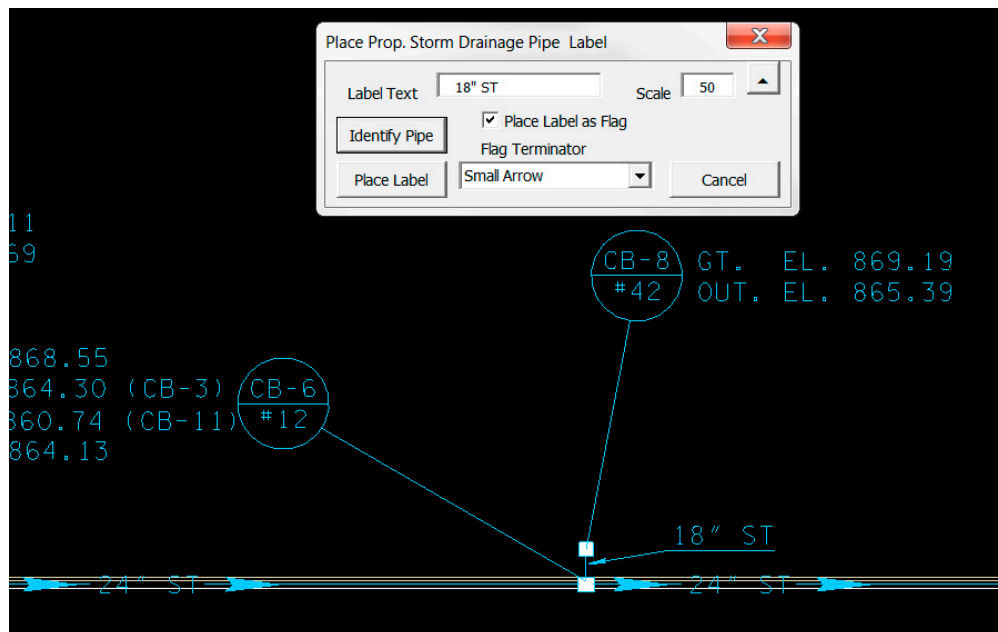
## Exercise 14

- Step 3.** Data point on or near the pipe for the beginnig of the leader and once again to position the label which is shown dynamically..



- Step 3.** Use the **Identify Pipe** button to read and **label** the other short pipe links on the project.

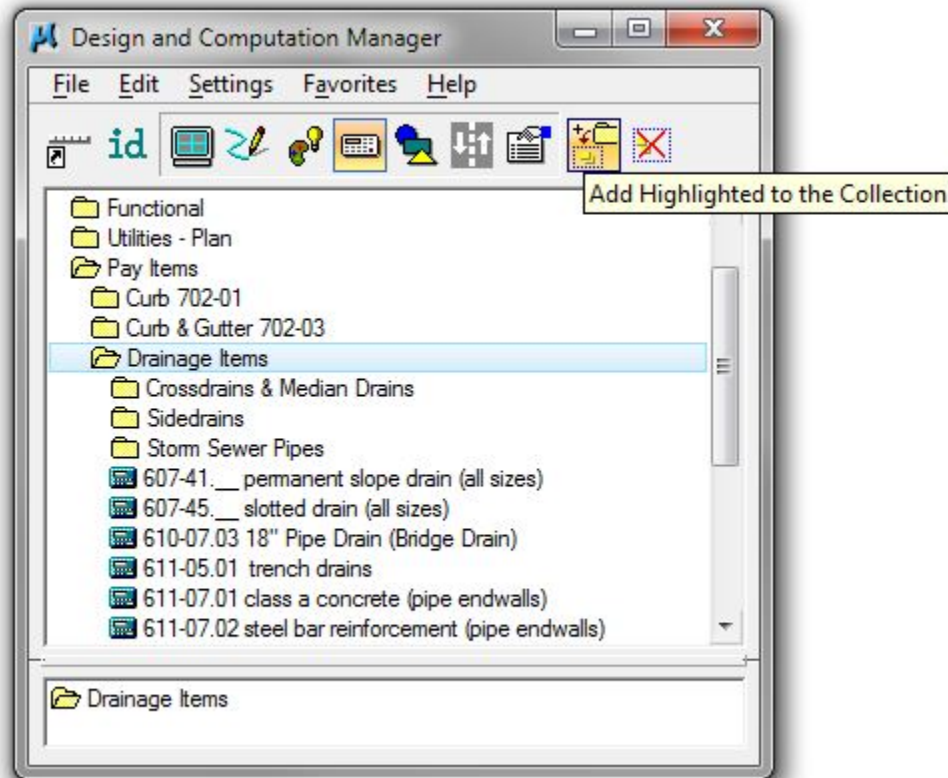
You may wish to use one of the terminator options for pipes in tight places with other text and line work.



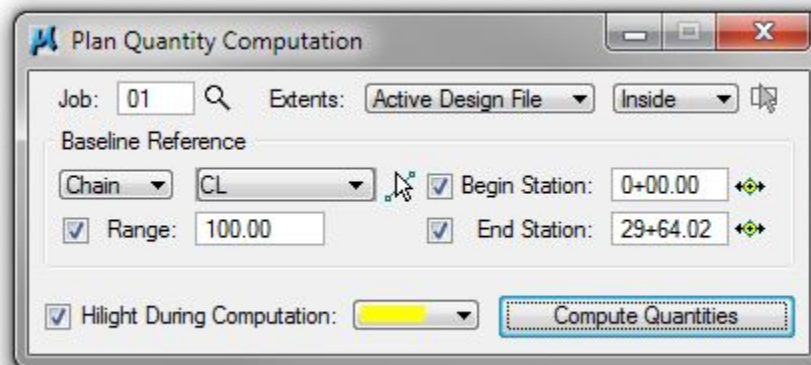


## 14.3 Compute Link Quantities

- Step 1.** Open the Design and Computation Manager and set the Mode to Compute by clicking the '**calculator**' icon button.
- Step 2.** Under **Pay Items**, highlight the **Prop. Drainage** category, then click the **Add to Collection** button on the Design & Computation Manager toolbar.



- Step 3.** Within the Plan Quantity Computation box ensure Extents: is set to **Active Design File**. Click the Compute Quantities button for initiation of the report. Your results may vary.



**NOTE:** To limit the extent of calculation set Extents: to Station Range, and set the limits desired in the *Baseline Reference* portion of the dialog.

# Exercise 14

**Step 4.** Select your Export Format. Select **CSV By Item** for use with standard estimate files. Type in drainage.csv for the filename and click on **Export**.

The 'Computation Results' dialog box displays a table of items and their quantities. Below the table, the 'Export Format' is set to 'CSV By Item', the filename is 'drainage.csv', and the 'Phase' is 'DesignEstimate'.

Item	Description	Quantity	Unit	Export
607-03.02	18" storm sewer pipe Class 3	690.00	LF	<input checked="" type="checkbox"/>
607-05.02	24" storm sewer pipe Class 3	1002.00	LF	<input checked="" type="checkbox"/>
607-06.02	30" storm sewer pipe Class 3	191.00	LF	<input checked="" type="checkbox"/>
607-07.02	36" storm sewer pipe Class 3	74.00	LF	<input checked="" type="checkbox"/>

Export Format: **CSV By Item**    drainage.csv    Create    Export  
 Run:    Phase: **DesignEstimate**    Display

In the Estimated Roadway Quantities Excel file use the **Import CSV File for Items** command button to import the data compiled with D&C Manager.

**NOTE:** This function reads only the item number and quantity from the csv file. Item description and unit are pulled from the official item number listing.

The screenshot shows an Excel spreadsheet with the title 'Estimated Roadway Quantities1 - Microsoft Excel'. The spreadsheet contains a table titled 'ESTIMATED ROADWAY QUANTITIES' with columns for ITEM NO., DESCRIPTION, UNIT, and QUANTITY. The data is as follows:

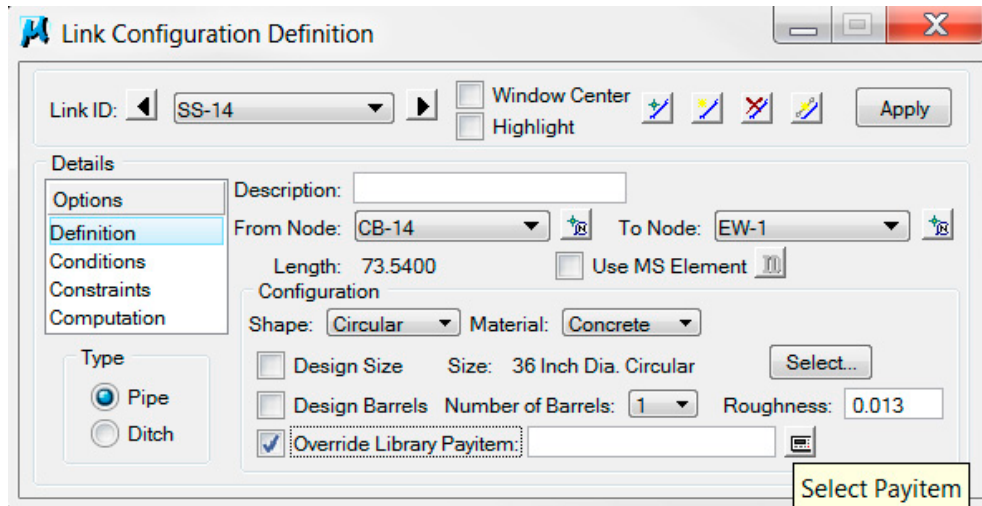
ITEM NO.	DESCRIPTION	UNIT	QUANTITY
607-03.02	18" CONCRETE PIPE CULVERT (CLASS III)	L.F.	690
607-05.02	24" CONCRETE PIPE CULVERT (CLASS III)	L.F.	1002
607-06.02	30" CONCRETE PIPE CULVERT (CLASS III)	L.F.	191
607-07.02	36" CONCRETE PIPE CULVERT (CLASS III)	L.F.	74

On the right side of the spreadsheet, there is a sidebar with several buttons: 'Select Items Numbers From List', 'Fill In Description and Unit', 'Download Items.dat from Web Page', 'Import CSV File for Items', 'Sort Item Numbers', 'Format Notes Area', 'Format Item Numbers', and '1 Column Format'. A note at the top of the sidebar states: 'These programs can also be accessed under View NOTE: This estimated roadway quantities file is de Project Data worksheet. The worksheets with the'.

## 14.4 Alternate Pay Items for Links

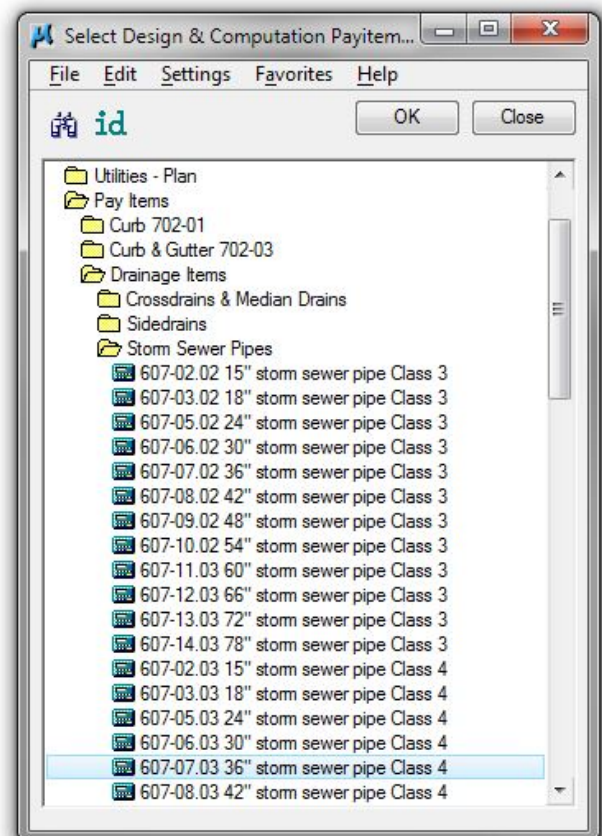
**Step 1.** Open Edit Link and select **Link SS-14**.

**Step 2.** In **Definition**, under the *Configuration* portion, toggle **ON** **Override Library Payitem**.



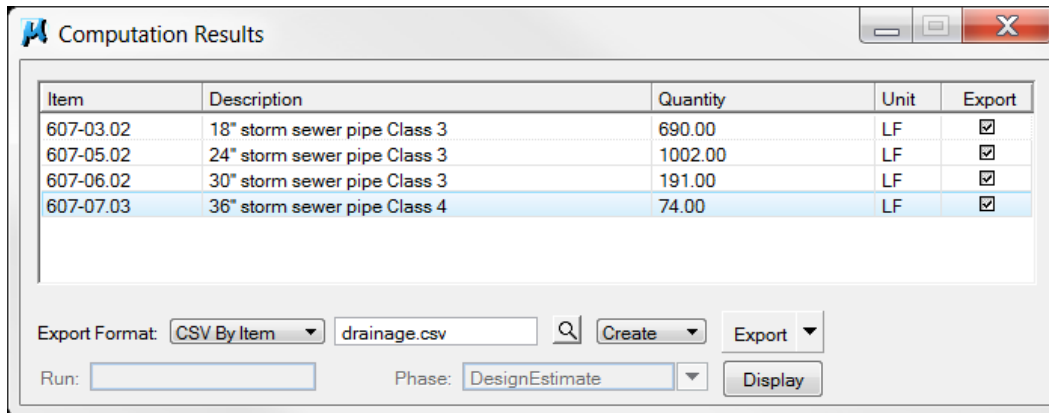
**Step 3.** Click on the calculator button to select an alternate pay item. Go to **Pay Items > Storm Sewer Pipes > 607-07.03 36" storm sewer pipe Class 4**. Double click on the 36" Class 4 Concrete pipe item to switch it from the defaulted Class 3 item number.

**NOTE:** All circular concrete pipes are set up with Class 3 concrete pipe item numbers. When setting up a system of median drains for depressed grass medians then all pipes will need to be set to use alternate pipe item numbers as listed under D & C manager category **Pay Items > Drainage Items > Crossdrains & Median Drains**.



## Exercise 14

- Step 4.** Click **Apply** in the Link Configuration Definition dialog to accept the change.  
Follow Exercise 14.1 to update the link graphics.  
Follow Exercise 14.3 to re-compute the quantities and see the difference.



The screenshot shows a window titled "Computation Results" with a table of items and their quantities. The table has five columns: Item, Description, Quantity, Unit, and Export. The data is as follows:

Item	Description	Quantity	Unit	Export
607-03.02	18" storm sewer pipe Class 3	690.00	LF	<input checked="" type="checkbox"/>
607-05.02	24" storm sewer pipe Class 3	1002.00	LF	<input checked="" type="checkbox"/>
607-06.02	30" storm sewer pipe Class 3	191.00	LF	<input checked="" type="checkbox"/>
607-07.03	36" storm sewer pipe Class 4	74.00	LF	<input checked="" type="checkbox"/>

Below the table, there are controls for exporting the data. The "Export Format" is set to "CSV By Item" and the filename is "drainage.csv". There are buttons for "Create", "Export", "Run", and "Display". The "Phase" is set to "DesignEstimate".





### T.D.O.T. Geopak Drainage Nodes

- Names for nodes indicate inside length & width dimensions of square structures or inside diameter of circular structures.
- All values are from T.D.O.T. Standard Roadway Drawings based on concrete pipe.
- For use with "Min Fixed Drop" option... Minimum Depth of Cover = Minimum Depth of Node - (Pipe Size + Drop Across Bottom of Structure) with both inlet & outlet pipes of the same size. **When node has outlet pipe only or the outlet pipe is larger than the inlet pipe, increase the minimum depth of cover by the drop across bottom of structure value.**
- If no values are entered under a pipe size this indicates that pipe size is not valid with that node.
- Any pipe size which includes a "W" with the minimum depth of cover value indicates the pipe size can only be used in the wide side of the structure.

**Table A Pipe Sizes 15" - 42"**

Drainage Node Name	Node Description	Cell Name	Drop Across Bottom of Structure	Max. Depth	Pipe Sizes											
					15			18			24			30		
					Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover
Type: Grate																
CB#10 32"X26"	Lowered 6-30 Curb & Grate Inlet	CB32X26S	0.12	5.08		2.12	4.28	2.16								
CB#10 4X3	6" NonMount. Curb & Grate Inlet	CB4X3S	0.17	20.00		3.88	2.21	4.42	2.25	4.96	W	2.29	5.50	W	2.33	
CB#10 4' DIA	6" NonMount. Curb & Grate Inlet	CB4DIAS	0.17	20.00		3.88	2.21	4.42	2.25							
CB#10 4X4	6" NonMount. Curb & Grate Inlet	CB4X4S	0.17	28.00		3.88	2.21	4.42	2.25	4.96		2.29	5.50		2.33	
CB#12 32"X32"	6" NonMount. Curb & Grate Inlet	CB32X32	0.12	4.58		3.74	2.12	4.28	2.16							
CB#12 4X3	6" NonMount. Curb & Grate Inlet	CB4X3	0.17	20.00		3.88	2.21	4.42	2.25	4.96	W	2.29	5.50	W	2.33	
CB#12 4' DIA	6" NonMount. Curb & Grate Inlet	CB4DIA	0.17	20.00		3.88	2.21	4.42	2.25							
CB#12 4X4	6" NonMount. Curb & Grate Inlet	CB4X4	0.17	28.00		3.88	2.21	4.42	2.25	4.96		2.29	5.50		2.33	
CB#12 5' DIA	6" NonMount. Curb & Grate Inlet	CB5DIA	0.21	40.00		3.92	2.21	4.46	2.25	5.00		2.29	5.55		2.34	6.09
CB#12 5'2"X5'2"	6" NonMount. Curb & Grate Inlet	CB62X62	0.22	28.00		4.13	2.41	4.67	2.45	5.22		2.50	5.76		2.54	6.30
CB#12 6' DIA	6" NonMount. Curb & Grate Inlet	CB6DIA	0.25	40.00		3.97	2.22	4.51	2.26	5.05		2.30	5.59		2.34	6.13
CB#12 7' DIA	6" NonMount. Curb & Grate Inlet	CB7DIA	0.29	40.00		4.34	2.55	4.88	2.59	5.42		2.63	5.97		2.68	6.51
CB#12 7X7	6" NonMount. Curb & Grate Inlet	CB7X7	0.29	28.00		4.17	2.38	4.72	2.43	5.26		2.47	5.80		2.51	6.34
CB#12 8' DIA	6" NonMount. Curb & Grate Inlet	CB8DIA	0.33	40.00		4.38	2.55	4.92	2.59	5.46		2.63	6.00		2.67	6.54
CB#12 9' DIA	6" NonMount. Curb & Grate Inlet	CB9DIA	0.38	40.00		4.42	2.54	4.96	2.58	5.50		2.62	6.04		2.66	6.58
CB#12 9X9	6" NonMount. Curb & Grate Inlet	CB9X9	0.38	28.00		4.25	2.37	4.79	2.41	5.33		2.45	5.88		2.50	6.42
CB#12 10' DIA	6" NonMount. Curb & Grate Inlet	CB10DIA	0.42	40.00		4.46	2.54	5.00	2.58	5.54		2.62	6.08		2.66	6.63
CB#13 4X3	6" NonMount. Curb & Grate Inlet	CB4X3	0.17	20.00		3.88	2.21	4.42	2.25	4.96	W	2.29	5.50	W	2.83	
CB#13 4' DIA	6" NonMount. Curb & Grate Inlet	CB4DIA	0.17	20.00		3.88	2.21	4.42	2.25							
CB#13 5' DIA	6" NonMount. Curb & Grate Inlet	CB5DIA	0.21	40.00		3.92	2.21	4.46	2.25	5.00		2.29	5.55		2.34	6.09

**Table A Pipe Sizes 15" - 42"**

Drainage Node Name	Node Description	Cell Name	Drop Across Bottom of Structure	Max. Depth	Pipe Sizes											
					15			18			24			30		
					Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover
Type: Grate																
CB#13 6' DIA	6" NonMount. Curb & Grate Inlet	CB6DIA	0.25	40.00		2.22	4.51	2.26	5.05	2.30	5.59	2.34	6.13	2.38		
CB#13 7' DIA	6" NonMount. Curb & Grate Inlet	CB7DIA	0.29	40.00		2.55	4.88	2.59	5.42	2.63	5.97	2.68	6.51	2.72		
CB#13 8' DIA	6" NonMount. Curb & Grate Inlet	CB8DIA	0.33	40.00		2.55	4.92	2.59	5.46	2.63	6.00	2.67	6.54	2.71		
CB#13 9' DIA	6" NonMount. Curb & Grate Inlet	CB9DIA	0.38	40.00		2.54	4.96	2.58	5.50	2.62	6.04	2.66	6.58	2.70		
CB#13 10' DIA	6" NonMount. Curb & Grate Inlet	CB10DIA	0.42	40.00		2.54	5.00	2.58	5.54	2.62	6.08	2.66	6.63	2.71		
CB#14 8X3	6" NonMount. Curb & Grate Inlet	CB8X3	0.33	20.00		2.22	4.59	2.26	5.13	W	2.30	5.67	6.21	W	2.38	
CB#14 8' DIA	6" NonMount. Curb & Grate Inlet	CB8DIA	0.33	40.00		2.55	4.92	2.59	5.46	2.63	6.00	2.67	6.54	2.71		
CB#14 9X9	6" NonMount. Curb & Grate Inlet	CB9X9	0.38	28.00		2.54	4.96	2.58	5.50	2.62	6.04	2.66	6.58	2.70		
CB#16 8X4	6" NonMount. Curb & Grate Inlet	CB8X4	0.33	20.00		2.22	4.59	2.26	5.13	2.30	5.67	2.34	6.21	W	2.38	
CB#17 8X5'2"	6" NonMount. Curb & Grate Inlet	CB8X62	0.33	20.00		2.39	4.76	2.43	5.30	2.47	5.84	2.51	6.38	2.55		
CB#25 32"X32"	6" Mountable Curb & Grate Inlet	CB32X32	0.12	4.58		2.12	4.28	2.16								
CB#25 4X3	6" Mountable Curb & Grate Inlet	CB4X3	0.17	20.00		2.21	4.42	2.25	4.96	W	2.29	5.50	W	2.33		
CB#25 4' DIA	6" Mountable Curb & Grate Inlet	CB4DIA	0.17	20.00		2.21	4.42	2.25	4.96							
CB#25 4X4	6" Mountable Curb & Grate Inlet	CB4X4	0.17	28.00		2.21	4.42	2.25	4.96							
CB#25 5' DIA	6" Mountable Curb & Grate Inlet	CB5DIA	0.21	40.00		2.21	4.46	2.25	5.00							
CB#25 5'2'X5'2"	6" Mountable Curb & Grate Inlet	CB62X62	0.22	28.00		2.41	4.67	2.45	5.22	2.50	5.76	2.54	6.30	2.58		
CB#25 6' DIA	6" Mountable Curb & Grate Inlet	CB6DIA	0.25	40.00		2.22	4.51	2.26	5.05	2.30	5.59	2.34	6.13	2.38		
CB#25 7' DIA	6" Mountable Curb & Grate Inlet	CB7DIA	0.29	40.00		2.55	4.88	2.59	5.42	2.63	5.97	2.68	6.51	2.72		
CB#25 7X7	6" Mountable Curb & Grate Inlet	CB7X7	0.29	28.00		2.38	4.72	2.43	5.26	2.47	5.80	2.51	6.34	2.55		
CB#25 8' DIA	6" Mountable Curb & Grate Inlet	CB8DIA	0.33	40.00		2.55	4.92	2.59	5.46	2.63	6.00	2.67	6.54	2.71		
CB#25 9X9	6" Mountable Curb & Grate Inlet	CB9X9	0.38	28.00		2.37	4.79	2.41	5.33	2.45	5.88	2.50	6.42	2.54		
CB#26 8X3	6" Mountable Curb & Grate Inlet	CB8X3	0.33	20.00		2.22	4.59	2.26	5.13	W	2.30	5.67	W	2.34	6.21	W
CB#27 8X4	6" Mountable Curb & Grate Inlet	CB8X4	0.33	20.00		2.22	4.59	2.26	5.13	2.30	5.67	2.34	6.21	W	2.38	
CB#28 32"X32"	4" Mountable Curb & Grate Inlet	CB32X32	0.12	4.58		2.12	4.28	2.16								
CB#28 4X3	4" Mountable Curb & Grate Inlet	CB4X3	0.17	20.00		2.21	4.42	2.25	4.96	W	2.29	5.50	W	2.33		
CB#28 4' DIA	4" Mountable Curb & Grate Inlet	CB4DIA	0.17	20.00		2.21	4.42	2.25								

Table A Pipe Sizes 15" - 42"

Drainage Node Name	Node Description	Cell Name	Drop Across Bottom of Structure	Max. Depth	Pipe Sizes											
					15			18			24			30		
					Min. Depth	Min. Depth of Cover		Min. Depth	Min. Depth of Cover		Min. Depth	Min. Depth of Cover		Min. Depth	Min. Depth of Cover	
Type: Grate																
CB#28 5' DIA	4" Mountable Curb & Grate Inlet	CB5DIA	0.21	40.00			3.92	2.21	4.46	2.25	5.00	2.29	5.55	2.34	6.09	2.38
CB#28 6' DIA	4" Mountable Curb & Grate Inlet	CB6DIA	0.25	40.00			3.97	2.22	4.51	2.26	5.05	2.30	5.59	2.34	6.13	2.38
CB#28 7' DIA	4" Mountable Curb & Grate Inlet	CB7DIA	0.29	40.00			4.34	2.55	4.88	2.59	5.42	2.63	5.97	2.68	6.51	2.72
CB#28 8' DIA	4" Mountable Curb & Grate Inlet	CB8DIA	0.33	40.00			4.38	2.55	4.92	2.59	5.46	2.63	6.00	2.67	6.54	2.71
CB#29 8X3	4" Mountable Curb & Grate Inlet	CB8X3	0.33	20.00			4.05	2.22	4.59	2.26	5.13	2.30	5.67	2.34	6.21	2.38
CB#31 7' DIA	Med. Barrier Curb & Grate Inlet	CB7DIAC	0.29	40.00			4.34	2.55	4.88	2.59	5.42	2.63	5.97	2.68	6.51	2.72
CB#31 7X7	Med. Barrier Curb & Grate Inlet	CB7X7C	0.29	28.00			4.34	2.55	4.88	2.59	5.42	2.63	5.97	2.68	6.51	2.72
CB#31 9X9	Med. Barrier Curb & Grate Inlet	CB9X9C	0.38	28.00			4.42	2.54	4.96	2.58	5.50	2.62	6.04	2.66	6.58	2.70
CB#32 32"x80"	Med. Barrier Curb & Grate Inlet	CB32X80C	0.12	6.00			3.74	2.12	4.28	2.16						
CB#38 32"x32"	Median Ditch Grate	CB32X32M	0.12	4.58			2.96	1.34	3.50	1.38						
CB#38 4X4	Median Ditch Grate	CB4X4M	0.17	28.00			3.80	2.13	4.34	2.17	4.88	2.21	5.42	2.25		
CB#38 5' DIA	Median Ditch Grate	CB5DIAM	0.21	40.00			3.84	2.13	4.38	2.17	4.92	2.21	5.46	2.25	6.00	2.29
CB#38 5'2"x5'2"	Median Ditch Grate	CB62X62M	0.22	28.00			4.05	2.33	4.59	2.37	5.13	2.41	5.67	2.45	6.22	2.50
CB#38 6' DIA	Median Ditch Grate	CB6DIAM	0.25	40.00			3.88	2.13	4.42	2.17	4.97	2.22	5.51	2.26	6.05	2.30
CB#38 7' DIA	Median Ditch Grate	CB7DIAM	0.29	40.00			4.26	2.47	4.80	2.51	5.34	2.55	5.88	2.59	6.42	2.63
CB#38 8' DIA	Median Ditch Grate	CB8DIAM	0.33	40.00			4.29	2.46	4.83	2.50	5.38	2.55	5.92	2.59	6.46	2.63
CB#39 4X4	Median Ditch Grate	CB4X4M	0.17	28.00			2.96	1.29	3.50	1.33	4.04	1.37	4.58	1.41		
CB#39 5'2"x5'2"	Median Ditch Grate	CB62X62M	0.22	28.00			4.13	2.41	4.67	2.45	5.22	2.50	5.76	2.54	6.30	2.58
CB#39 7' DIA	Median Ditch Grate	CB7DIAM	0.29	40.00			4.29	2.50	4.83	2.54	5.38	2.59	5.92	2.63	6.46	2.67
CB#39 7X7	Median Ditch Grate	CB7X7M	0.29	28.00			4.13	2.34	4.67	2.38	5.22	2.43	5.76	2.47	6.30	2.51
CB#39 8' DIA	Median Ditch Grate	CB8DIAM	0.33	40.00			4.42	2.59	4.96	2.63	5.50	2.67	6.04	2.71	6.58	2.75
CB#39 9X9	Median Ditch Grate	CB9X9M	0.38	28.00			4.21	2.33	4.75	2.37	5.29	2.41	5.83	2.45	6.38	2.50
CB#40 8X4	Median Ditch Grate	CB8X4M	0.33	20.00			3.13	1.30	3.67	1.34	4.21	1.38	4.75	1.42	5.29	1.46
CB#40 9X9	Median Ditch Grate	CB9X9M	0.38	28.00			4.38	2.50	4.92	2.54	5.46	2.58	6.00	2.62	6.54	2.66
CB#41 32"x32"	Med. Barrier Curb & Grate Inlet	CB32X32B	0.12	4.58			3.74	2.12	4.28	2.16						
CB#41 4X3	Med. Barrier Curb & Grate Inlet	CB4X3B	0.17	20.00			3.88	2.21	4.42	2.25	4.96	2.29	5.50	2.33		

**Table A Pipe Sizes 15" - 42"**

Drainage Node Name	Node Description	Cell Name	Drop Across Bottom of Structure	Max. Depth	Pipe Sizes											
					15			18			24			30		
					Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover
Type: Grate																
CB#41 4X4	Med. Barrier Curb & Grate Inlet	CB4X4B	0.17	28.00			3.88	2.21	4.42	2.25	4.96	2.29	5.50	2.33		
CB#41 5' DIA	Med. Barrier Curb & Grate Inlet	CB5DIAB	0.21	40.00			3.92	2.21	4.46	2.25	5.00	2.29	5.55	2.34	6.09	2.38
CB#41 5'2"X5'2"	Med. Barrier Curb & Grate Inlet	CB62X62B	0.22	28.00			4.13	2.41	4.67	2.45	5.22	2.50	5.76	2.54	6.30	2.58
CB#41 6' DIA	Med. Barrier Curb & Grate Inlet	CB6DIAB	0.25	40.00			3.97	2.22	4.51	2.26	5.05	2.30	5.59	2.34	6.13	2.38
CB#41 7' DIA	Med. Barrier Curb & Grate Inlet	CB7DIAB	0.29	40.00			4.34	2.55	4.88	2.59	5.42	2.63	5.97	2.68	6.51	2.72
CB#41 7X7	Med. Barrier Curb & Grate Inlet	CB7X7B	0.29	28.00			4.17	2.38	4.72	2.43	5.26	2.47	5.80	2.51	6.34	2.55
CB#41 8' DIA	Med. Barrier Curb & Grate Inlet	CB8DIAB	0.33	40.00			4.38	2.55	4.92	2.59	5.46	2.63	6.00	2.67	6.54	2.71
CB#41 9X9	Med. Barrier Curb & Grate Inlet	CB9X9B	0.38	28.00			4.25	2.38	4.79	2.42	5.33	2.46	5.88	2.51	6.42	2.55
CB#42 32"X32"	Drop Inlet Grate	DI32X32	0.12	5.08			2.96	1.34	3.50	1.38						
CB#42 4X4	Drop Inlet Grate	DI4X4	0.17	28.00			3.80	2.13	4.34	2.17	4.88	2.21	5.42	2.25		
CB#42 5' DIA	Drop Inlet Grate	DI5DIA	0.21	40.00			3.84	2.13	4.38	2.17	4.92	2.21	5.46	2.25	6.00	2.29
CB#42 5'2"X5'2"	Drop Inlet Grate	DI62X62	0.22	28.00			4.05	2.33	4.59	2.37	5.13	2.41	5.67	2.45	6.22	2.50
CB#42 6' DIA	Drop Inlet Grate	DI6DIA	0.25	40.00			3.88	2.13	4.42	2.17	4.97	2.22	5.51	2.26	6.05	2.30
CB#42 7' DIA	Drop Inlet Grate	DI7DIA	0.29	40.00			4.26	2.47	4.80	2.51	5.34	2.55	5.88	2.59	6.42	2.63
CB#42 7X7	Drop Inlet Grate	DI7X7	0.29	28.00			4.26	2.47	4.80	2.51	5.34	2.55	5.88	2.59	6.42	2.63
CB#42 8' DIA	Drop Inlet Grate	DI8DIA	0.33	40.00			4.29	2.46	4.83	2.50	5.38	2.55	5.92	2.59	6.46	2.63
CB#43 8X4	Drop Inlet Grate	DI8X4	0.33	20.00			3.88	2.05	4.42	2.09	4.97	2.14	5.51	2.18	6.05	2.22
CB#43 8X5'2"	Drop Inlet Grate	DI8X62	0.33	20.00			4.13	2.30	4.67	2.34	5.22	2.39	5.76	2.43	6.30	2.47
CB#43 8' DIA	Drop Inlet Grate	DI8DIA	0.33	40.00			4.29	2.46	4.83	2.50	5.38	2.55	5.92	2.59	6.46	2.63
CB#44 9X9	Drop Inlet Grate	DI9X9	0.38	28.00			4.33	2.45	4.88	2.50	5.42	2.54	5.96	2.58	6.50	2.62
CB#45 8X4	Med. Barrier Curb & Grate Inlet	CB8X4B	0.33	20.00			4.05	2.22	4.59	2.26	5.13	2.30	5.67	2.34	6.21	2.38
CB#46 9X9	Med. Barrier Curb & Grate Inlet	CB9X9C	0.38	28.00			4.42	2.54	4.96	2.58	5.50	2.62	6.04	2.66	6.58	2.70
CB#51 5'2"X5'2"	Retaining Wall Curb & Grate Inlet	CB62X62R	0.22	28.00			4.13	2.41	4.67	2.45	5.22	2.50	5.76	2.54	6.30	2.58
CB#51 7X7	Retaining Wall Curb & Grate Inlet	CB7X7R	0.29	28.00			4.34	2.55	4.88	2.59	5.42	2.63	5.97	2.68	6.51	2.72
CB#51 9X9	Retaining Wall Curb & Grate Inlet	CB9X9R	0.38	28.00			4.58	2.71	5.13	2.76	5.67	2.80	6.21	2.84	6.75	2.88
CB#52 9X9	Retaining Wall Curb & Grate Inlet	CB9X9R	0.38	28.00			4.58	2.71	5.13	2.76	5.67	2.80	6.21	2.84	6.75	2.88

Table A Pipe Sizes 15" - 42"

Drainage Node Name	Node Description	Cell Name	Drop Across Bottom of Structure	Max. Depth	Pipe Sizes											
					15			18			24			30		
					Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover
Type: Junction																
MH#3 4' DIA	Manhole	MH4DIA	0.17	40.00		3.54	1.87	4.08	1.91							
MH#3 5' DIA	Manhole	MH5DIA	0.21	40.00		3.54	1.83	4.08	1.87					1.96		
MH#3 5'2"x5'2"	Manhole	MH62X62	0.22	28.00		4.19	2.47	4.73	2.51					5.81		
MH#3 6' DIA	Manhole	MH6DIA	0.25	40.00		3.63	1.88	4.17	1.92					5.25		
MH#3 7' DIA	Manhole	MH7DIA	0.29	40.00		3.63	1.84	4.17	1.88					5.25		
MH#3 7X7	Manhole	MH7X7	0.29	28.00		4.40	2.61	4.94	2.65					6.02		
MH#3 8' DIA	Manhole	MH8DIA	0.33	40.00		3.71	1.88	4.25	1.92					5.33		
MH#3 9' DIA	Manhole	MH9DIA	0.38	40.00		3.71	1.83	4.25	1.87					5.33		
MH#3 9X9	Manhole	MH9X9	0.38	28.00		4.40	2.52	4.94	2.56					6.02		
MH#3 10' DIA	Manhole	MH10DIA	0.42	40.00		3.71	1.79	4.25	1.83					5.33		
JB#1 32"x32"	Junction Box*	JB32X32	0.12	50.00		3.29	1.67	3.83	1.71							
JB#2 4X4	Junction Box*	JB4X4	0.17	50.00		3.29	1.62	3.83	1.66					4.92		
JB#3 5'2"x5'2"	Junction Box*	JB62X62	0.22	50.00		3.63	1.91	4.17	1.95					5.25		
JB#4 7X7	Junction Box*	JB7X7	0.29	30.00		3.83	2.04	4.38	2.09					5.46		
JB#5 9X9	Junction Box*	JB9X9	0.38	30.00		4.17	2.29	4.71	2.33					5.79		
JB#6 4' DIA	Junction Box*	JB4DIA	0.17	20.00		3.88	2.21	4.42	2.25							
JB#6 5' DIA	Junction Box*	JB5DIA	0.21	40.00		3.92	2.21	4.46	2.25					5.55		
JB#6 6' DIA	Junction Box*	JB6DIA	0.25	40.00		3.97	2.22	4.51	2.26					5.59		
JB#6 7' DIA	Junction Box*	JB7DIA	0.29	40.00		4.34	2.55	4.88	2.59					5.97		
JB#6 8' DIA	Junction Box*	JB8DIA	0.33	40.00		4.38	2.55	4.92	2.59					6.00		
JB#6 9' DIA	Junction Box*	JB9DIA	0.38	40.00		4.42	2.54	4.96	2.58					6.04		
JB#6 10' DIA	Junction Box*	JB10DIA	0.42	40.00		4.46	2.54	5.00	2.58					6.08		
Stub	Stub into Culvert	STUB	0.00	none	0.00	0.00	0.00	0.00	0.00					0.00		

\* Maximum Depth for use in Geopak equals tabulated depth (to top of structure) + Minimum Depth based on pipe size.  
Add an additional 2 feet for minimum cover over structure to Minimum Depth of Cover if junction box is within the clear zone.

Type: Outlet																
Endwall	Endwall for outlet pipe(generic)	EW	0.00	Pipe Size*	1.25	0.00	1.50	0.00	2.00	0.00	2.50	0.00	3.00	0.00	3.50	0.00
Outlet Stub	Stub into existing structure	STUB	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ditch Outlet	Special ditch end	STUB	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

\* During initial design, set the Maximum Depth to a value greater than the expected pipe size and the Minimum Depth of Cover to 0.00. Once pipe size is determined, reset the Maximum Depth to the designed pipe size + the distance to the top lip of the endwall to be used with the pipe and reset the Minimum Depth of Cover to the distance to the top lip of the endwall.



**Table A Pipe Sizes 15" - 42"**

Drainage Node Name	Node Description	Cell Name	Drop Across Bottom of Structure	Max. Depth	Pipe Sizes											
					15			18			24			30		
Type: Other					Min. Depth	Min. Depth of Cover	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth of Cover
EW Inlet	Endwall inlet into drainage system	EW	0.00	Pipe Size*	1.25	0.00	1.50	0.00	2.00	0.00	2.50	0.00	3.00	0.00	3.50	0.00
Ditch Begin	Begin special ditch	STUB	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ditch Change	Special ditch shape change	STUB	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

\* During initial design, set the Maximum Depth to a value greater than the expected pipe size and the Minimum Depth of Cover to 0.00. Once pipe size is determined, reset the Maximum Depth to the designed pipe size + the distance to the top lip of the endwall to be used with the pipe and reset the Minimum Depth of Cover to the distance to the top lip of the endwall.

**Type: Headwall**

Culvert Endwall	Pipe Culvert Endwall(generic)	EW	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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**Type: Grate - Bridge Drains**

BD 2'X8'7"	Bridge End Drain	BD2X8	0.00	3.50			3.50	2.00								
BD 4'X8'7"	Bridge End Drain	BD4X8	0.00	3.50			3.50	2.00								
								9								
BD 2'X9"	Bridge Deck Drain	BD9X2	0.00	1.50	1.25	0.75	1.50	0.75								

**Type: Curb - Bridge Drains**

BD-PRPT	Bridge Deck Drain - Parapet	BDPRPT	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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**Type: Slotted Drain**

SD 12"	Slotted Drain	SLOT12	0.00	1.50	1.50	0.50										
SD 15"	Slotted Drain	SLOT15	0.00	1.75			1.75	0.50								
SD 18"	Slotted Drain	SLOT18	0.00	2.00				2.00	0.50							
SD 24"	Slotted Drain	SLOT24	0.00	2.50						2.50	0.50					
SD 30"	Slotted Drain	SLOT30	0.00	3.00								3.00	0.50			
SD 36"	Slotted Drain	SLOT36	0.00	3.50										3.50	0.50	

Table B Pipe Sizes 48" - 78"

Drainage Node Name	Node Description	Cell Name	Drop Across Bottom of Structure	Max. Depth	Pipe Sizes											
					48			54			60			66		
					Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth	Min. Depth of Cover	Min. Depth of Cover
Type: Grate																
CB#10 32"X26"	Lowered 6-30 Curb & Grate Inlet	CB32X26S	0.12	5.08												
CB#10 4X3	6" NonMount. Curb & Grate Inlet	CB4X3S	0.17	20.00												
CB#10 4' DIA	6" NonMount. Curb & Grate Inlet	CB4DIAS	0.17	20.00												
CB#10 4X4	6" NonMount. Curb & Grate Inlet	CB4X4S	0.17	20.00												
CB#12 32"X32"	6" NonMount. Curb & Grate Inlet	CB32X32	0.12	4.58												
CB#12 4X3	6" NonMount. Curb & Grate Inlet	CB4X3	0.17	20.00												
CB#12 4' DIA	6" NonMount. Curb & Grate Inlet	CB4DIA	0.17	20.00												
CB#12 4X4	6" NonMount. Curb & Grate Inlet	CB4X4	0.17	28.00												
CB#12 5' DIA	6" NonMount. Curb & Grate Inlet	CB5DIA	0.21	40.00	6.63	2.42										
CB#12 5'2"X5'2"	6" NonMount. Curb & Grate Inlet	CB62X62	0.22	28.00	6.84	2.62										
CB#12 6' DIA	6" NonMount. Curb & Grate Inlet	CB6DIA	0.25	40.00	6.67	2.42										
CB#12 7' DIA	6" NonMount. Curb & Grate Inlet	CB7DIA	0.29	40.00	7.05	2.76	7.59	2.80	2.80	8.13	2.84	8.67	2.88	9.22	9.76	2.97
CB#12 7X7	6" NonMount. Curb & Grate Inlet	CB7X7	0.29	28.00	6.88	2.59	7.42	2.63	2.63	7.97	2.68	8.51	2.72			
CB#12 8' DIA	6" NonMount. Curb & Grate Inlet	CB8DIA	0.33	40.00	7.08	2.75	7.63	2.80	2.80	8.17	2.84	8.71	2.88	9.25	9.79	2.96
CB#12 9' DIA	6" NonMount. Curb & Grate Inlet	CB9DIA	0.38	40.00	7.13	2.75	7.67	2.79	2.79	8.21	2.83	8.75	2.87	9.29	9.83	2.95
CB#12 9X9	6" NonMount. Curb & Grate Inlet	CB9X9	0.38	28.00	6.96	2.58	7.50	2.62	2.62	8.04	2.66	8.58	2.70	9.13	9.67	2.79
CB#12 10' DIA	6" NonMount. Curb & Grate Inlet	CB10DIA	0.42	40.00	7.17	2.75	7.71	2.79	2.79	8.25	2.83	8.79	2.87	9.33	9.88	2.96
CB#13 4X3	6" NonMount. Curb & Grate Inlet	CB4X3	0.17	20.00												
CB#13 4' DIA	6" NonMount. Curb & Grate Inlet	CB4DIA	0.17	20.00												
CB#13 5' DIA	6" NonMount. Curb & Grate Inlet	CB5DIA	0.21	40.00	6.63	2.42										
CB#13 6' DIA	6" NonMount. Curb & Grate Inlet	CB6DIA	0.25	40.00	6.67	2.42										
CB#13 7' DIA	6" NonMount. Curb & Grate Inlet	CB7DIA	0.29	40.00	7.05	2.76	7.59	2.80	2.80	8.13	2.84	8.67	2.88	9.22	9.76	2.97
CB#13 8' DIA	6" NonMount. Curb & Grate Inlet	CB8DIA	0.33	40.00	7.08	2.75	7.63	2.80	2.80	8.17	2.84	8.71	2.88	9.25	9.79	2.96
CB#13 9' DIA	6" NonMount. Curb & Grate Inlet	CB9DIA	0.38	40.00	7.13	2.75	7.67	2.79	2.79	8.21	2.83	8.75	2.87	9.29	9.83	2.95
CB#13 10' DIA	6" NonMount. Curb & Grate Inlet	CB10DIA	0.42	40.00	7.17	2.75	7.71	2.79	2.79	8.25	2.83	8.79	2.87	9.33	9.88	2.96
CB#14 8X3	6" NonMount. Curb & Grate Inlet	CB8X3	0.33	20.00	6.75	2.42	7.30	2.47	2.47	7.84	2.51					

**Table B Pipe Sizes 48" - 78"**

Drainage Node Name	Node Description	Cell Name	Drop Across Bottom of Structure	Max. Depth	Pipe Sizes											
					48		54		60		66		72		78	
Type: Grade					Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover
CB#14 8' DIA	6" NonMount. Curb & Grate Inlet	CB8DIA	0.33	40.00	7.08	2.75	7.63	2.80	8.17	2.84	8.71	2.88				
CB#14 9X9	6" NonMount. Curb & Grate Inlet	CB9X9	0.38	28.00	7.13	2.75	7.67	2.79	8.21	2.83	8.75	2.87			9.83	2.95
CB#16 8X4	6" NonMount. Curb & Grate Inlet	CB8X4	0.33	20.00	6.75	2.42	7.30	W	7.84	W	2.51					
CB#17 8X5"2"	6" NonMount. Curb & Grate Inlet	CB8X62	0.33	20.00	6.92	2.59	7.47	W	8.01	W	2.68					
CB#25 32"X32"	6" Mountable Curb & Grate Inlet	CB32X32	0.12	4.58												
CB#25 4X3	6" Mountable Curb & Grate Inlet	CB4X3	0.17	20.00												
CB#25 4' DIA	6" Mountable Curb & Grate Inlet	CB4DIA	0.17	20.00												
CB#25 4X4	6" Mountable Curb & Grate Inlet	CB4X4	0.17	28.00												
CB#25 5' DIA	6" Mountable Curb & Grate Inlet	CB5DIA	0.21	40.00	6.63	2.42	7.17	2.46	7.71	2.50	8.25	2.54				
CB#25 5'2"X5'2"	6" Mountable Curb & Grate Inlet	CB62X62	0.22	28.00	6.84	2.62										
CB#25 6' DIA	6" Mountable Curb & Grate Inlet	CB6DIA	0.25	40.00	6.67	2.42	7.22	2.47	7.76	2.51	8.30	2.55				
CB#25 7' DIA	6" Mountable Curb & Grate Inlet	CB7DIA	0.29	40.00	7.05	2.76	7.59	2.80	8.13	2.84	8.67	2.88				
CB#25 7X7	6" Mountable Curb & Grate Inlet	CB7X7	0.29	28.00	6.88	2.59	7.42	2.63	7.97	2.68	8.51	2.72				
CB#25 8' DIA	6" Mountable Curb & Grate Inlet	CB8DIA	0.33	40.00	7.08	2.75	7.63	2.80	8.17	2.84	8.71	2.88				
CB#25 9X9	6" Mountable Curb & Grate Inlet	CB9X9	0.38	28.00	6.96	2.58	7.50	2.62	8.04	2.66	8.58	2.70			9.67	2.79
CB#26 8X3	6" Mountable Curb & Grate Inlet	CB8X3	0.33	20.00	6.75	2.42	7.30	W	7.84	W	2.51					
CB#27 8X4	6" Mountable Curb & Grate Inlet	CB8X4	0.33	20.00	6.75	2.42	7.30	W	7.84	W	2.51					
CB#28 32"X32"	4" Mountable Curb & Grate Inlet	CB32X32	0.12	4.58												
CB#28 4X3	4" Mountable Curb & Grate Inlet	CB4X3	0.17	20.00												
CB#28 4' DIA	4" Mountable Curb & Grate Inlet	CB4DIA	0.17	20.00												
CB#28 5' DIA	4" Mountable Curb & Grate Inlet	CB5DIA	0.21	40.00	6.63	2.42	7.17	2.46	7.71	2.50	8.25	2.54				
CB#28 6' DIA	4" Mountable Curb & Grate Inlet	CB6DIA	0.25	40.00	6.67	2.42	7.22	2.47	7.76	2.51	8.30	2.55				
CB#28 7' DIA	4" Mountable Curb & Grate Inlet	CB7DIA	0.29	40.00	7.05	2.76	7.59	2.80	8.13	2.84	8.67	2.88				
CB#28 8' DIA	4" Mountable Curb & Grate Inlet	CB8DIA	0.33	40.00	7.08	2.75	7.63	2.80	8.17	2.84	8.71	2.88				
CB#29 8X3	4" Mountable Curb & Grate Inlet	CB8X3	0.33	20.00	6.75	2.42	7.30	W	7.84	W	2.51					
CB#31 7' DIA	Med. Barrier Curb & Grate Inlet	CB7DIAC	0.29	40.00	7.05	2.76	7.59	2.80	8.13	2.84						

Table B Pipe Sizes 48" - 78"

Drainage Node Name	Node Description	Cell Name	Drop Across Bottom of Structure	Max. Depth	Pipe Sizes											
					48			54			60			66		
					Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth	Min. Depth of Cover	Min. Depth of Cover
Type: Gate																
CB#31 7X7	Med. Barrier Curb & Gate Inlet	CB7X7C	0.29	28.00	7.05	2.76	7.59	2.80	8.13	2.84	8.67	2.88				
CB#31 9X9	Med. Barrier Curb & Gate Inlet	CB9X9C	0.38	28.00	7.13	2.75	7.67	2.79	8.21	2.83	8.75	2.87			9.83	2.95
CB#32 32"X80"	Med. Barrier Curb & Gate Inlet	CB32X80C	0.12	6.00												
CB#38 32"X32"	Median Ditch Gate	CB32X32M	0.12	4.58												
CB#38 4X4	Median Ditch Gate	CB4X4M	0.17	28.00												
CB#38 5' DIA	Median Ditch Gate	CB5DIAM	0.21	40.00	6.55	2.34	7.09	2.38	7.63	2.42	8.17	2.46				
CB#38 5'2"X5'2"	Median Ditch Gate	CB62X62M	0.22	28.00	6.76	2.54										
CB#38 6' DIA	Median Ditch Gate	CB6DIAM	0.25	40.00	6.59	2.34	7.13	2.38	7.67	2.42	8.22	2.47				
CB#38 7' DIA	Median Ditch Gate	CB7DIAM	0.29	40.00	6.97	2.68	7.51	2.72	8.05	2.76	8.59	2.80				
CB#38 8' DIA	Median Ditch Gate	CB8DIAM	0.33	40.00	7.00	2.67	7.54	2.71	8.08	2.75	8.63	2.80				
CB#39 4X4	Median Ditch Gate	CB4X4M	0.17	28.00												
CB#39 5'2"X5'2"	Median Ditch Gate	CB62X62M	0.22	28.00	6.84	2.62										
CB#39 7' DIA	Median Ditch Gate	CB7DIAM	0.29	40.00	7.00	2.71	7.54	2.75	8.08	2.79	8.63	2.84				
CB#39 7X7	Median Ditch Gate	CB7X7M	0.29	28.00	6.84	2.55	7.38	2.59	7.92	2.63	8.47	2.68				
CB#39 8' DIA	Median Ditch Gate	CB8DIAM	0.33	40.00	7.13	2.80	7.67	2.84	8.21	2.88	8.75	2.92				
CB#39 9X9	Median Ditch Gate	CB9X9M	0.38	28.00	6.92	2.54	7.46	2.58	8.00	2.62	8.54	2.66			9.63	2.75
CB#40 8X4	Median Ditch Gate	CB8X4M	0.33	20.00	5.83	1.50	6.38	1.55	6.92	1.59						
CB#40 9X9	Median Ditch Gate	CB9X9M	0.38	28.00	7.08	2.70	7.63	2.75	8.17	2.79	8.71	2.83			9.79	2.91
CB#41 32"X32"	Med. Barrier Curb & Gate Inlet	CB32X32B	0.12	4.58												
CB#41 4X3	Med. Barrier Curb & Gate Inlet	CB4X3B	0.17	20.00												
CB#41 4X4	Med. Barrier Curb & Gate Inlet	CB4X4B	0.17	28.00												
CB#41 5' DIA	Med. Barrier Curb & Gate Inlet	CB5DIAB	0.21	40.00	6.63	2.42	7.17	2.46	7.71	2.50	8.25	2.54				
CB#41 5'2"X5'2"	Med. Barrier Curb & Gate Inlet	CB62X62B	0.22	28.00	6.84	2.62										
CB#41 6' DIA	Med. Barrier Curb & Gate Inlet	CB6DIAB	0.25	40.00	6.67	2.42	7.22	2.47	7.76	2.51	8.30	2.55				
CB#41 7' DIA	Med. Barrier Curb & Gate Inlet	CB7DIAB	0.29	40.00	7.05	2.76	7.59	2.80	8.13	2.84	8.67	2.88				
CB#41 7X7	Med. Barrier Curb & Gate Inlet	CB7X7B	0.29	28.00	6.88	2.59	7.42	2.63	7.97	2.68	8.51	2.72				

**Table B Pipe Sizes 48" - 78"**

Drainage Node Name	Node Description	Cell Name	Drop Across Bottom of Structure	Max. Depth	Pipe Sizes											
					48			54			60			66		
					Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth	Min. Depth of Cover	Min. Depth
Type: Gate																
CB#41 8' DIA	Med. Barrier Curb & Grate Inlet	CB8DIAB	0.33	40.00	7.08	2.75	7.63	2.80	8.17	2.84	8.71	2.88				
CB#41 9X9	Med. Barrier Curb & Grate Inlet	CB9X9B	0.38	28.00	6.96	2.59	7.50	2.63	8.04	2.67	8.58	2.71	9.13	2.76	9.67	2.80
CB#42 32"X32"	Drop Inlet Grate	DI32X32	0.12	5.08												
CB#42 4X4	Drop Inlet Grate	DI4X4	0.17	28.00												
CB#42 5' DIA	Drop Inlet Grate	DI5DIA	0.21	40.00	6.55	2.34	7.09	2.38	7.63	2.42	8.17	2.46				
CB#42 5'2"X5'2"	Drop Inlet Grate	DI62X62	0.22	28.00	6.76	2.54										
CB#42 6' DIA	Drop Inlet Grate	DI6DIA	0.25	40.00	6.59	2.34	7.13	2.38	7.67	2.42	8.22	2.47				
CB#42 7' DIA	Drop Inlet Grate	DI7DIA	0.29	40.00	6.97	2.68	7.51	2.72	8.05	2.76	8.59	2.80				
CB#42 7X7	Drop Inlet Grate	DI7X7	0.29	28.00	6.97	2.68	7.51	2.72	8.05	2.76						
CB#42 8' DIA	Drop Inlet Grate	DI8DIA	0.33	40.00	7.00	2.67	7.54	2.71	8.08	2.75	8.63	2.80				
CB#43 8X4	Drop Inlet Grate	DI8X4	0.33	20.00	6.59	W	2.26	7.13	W	2.30	7.67	W	2.34			
CB#43 8X5'2"	Drop Inlet Grate	DI8X62	0.33	20.00	6.84	2.51	7.38	W	7.92	W						
CB#43 8' DIA	Drop Inlet Grate	DI8DIA	0.33	40.00	7.00	2.67	7.54	2.71	8.08	2.75	8.63	2.80				
CB#44 9X9	Drop Inlet Grate	DI9X9	0.38	28.00	7.04	2.66	7.58	2.70	8.13	2.75	8.67	2.79	9.21	2.83	9.75	2.87
CB#45 8X4	Med. Barrier Curb & Grate Inlet	CB8X4B	0.33	20.00	6.75	W	2.42	7.30	W	2.47	W					
CB#46 9X9	Med. Barrier Curb & Grate Inlet	CB9X9C	0.38	28.00	7.13	2.75	7.67	2.79	8.21	2.83	8.75	2.87	9.29	2.91	9.83	2.95
CB#51 5'2"X5'2"	Retaining Wall Curb & Grate Inlet	CB62X62R	0.22	28.00	6.84	2.62										
CB#51 7X7	Retaining Wall Curb & Grate Inlet	CB7X7R	0.29	28.00	7.05	2.76	7.59	2.80	8.13	2.84	8.67	2.88				
CB#51 9X9	Retaining Wall Curb & Grate Inlet	CB9X9R	0.38	28.00	7.29	2.92	7.83	2.96	8.38	3.01	8.92	3.05	9.46	3.09	10.00	3.13
CB#52 9X9	Retaining Wall Curb & Grate Inlet	CB9X9R	0.38	28.00	7.29	2.92	7.83	2.96	8.38	3.01	8.92	3.05	9.46	3.09	10.00	3.13



Table B Pipe Sizes 48" - 78"

Drainage Node Name	Node Description	Cell Name	Drop Across Bottom of Structure	Max. Depth	Pipe Sizes											
					48			54			60			66		
					Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth of Cover
Type: Junction																
MH#3 4' DIA	Manhole	MH4DIA	0.17	40.00												
MH#3 5' DIA	Manhole	MH5DIA	0.21	40.00												
MH#3 5'2"X5'2"	Manhole	MH62X62	0.22	28.00	6.90	2.68										
MH#3 6' DIA	Manhole	MH6DIA	0.25	40.00	6.33	2.08										
MH#3 7' DIA	Manhole	MH7DIA	0.29	40.00	6.33	2.04	6.88	2.09	2.13	7.42	2.90	8.73	2.94			
MH#3 7X7	Manhole	MH7X7	0.29	28.00	7.10	2.81	7.65	2.86	2.90	8.19	2.81	8.73	2.85	2.20		
MH#3 8' DIA	Manhole	MH8DIA	0.33	40.00	6.42	2.09	6.96	2.13	2.17	7.50	2.81	8.04	2.21			
MH#3 9' DIA	Manhole	MH9DIA	0.38	40.00	6.42	2.04	6.96	2.08	2.12	7.50	2.81	8.04	2.12	8.58	2.20	
MH#3 9X9	Manhole	MH9X9	0.38	28.00	7.10	2.72	7.65	2.77	2.81	8.19	2.81	8.73	2.85	9.27	2.89	9.81
MH#3 10' DIA	Manhole	MH10DIA	0.42	40.00	6.42	2.00	6.96	2.04	2.08	7.50	2.81	8.04	2.12	8.58	2.16	9.13
JB#1 3'2"X3'2"	Junction Box*	JB32X32	0.12	50.00												
JB#2 4X4	Junction Box*	JB4X4	0.17	50.00												
JB#3 5'2"X5'2"	Junction Box*	JB62X62	0.22	30.00	6.33	2.11										
JB#4 7X7	Junction Box*	JB7X7	0.29	30.00	6.54	2.25	7.08	2.29	2.34	7.63	2.34	8.17	2.38			
JB#5 9X9	Junction Box*	JB9X9	0.38	30.00	6.88	2.50	7.42	2.54	2.58	7.96	2.58	8.50	2.62	9.04	2.66	9.58
JB#6 4' DIA	Junction Box*	JB4DIA	0.17	20.00												
JB#6 5' DIA	Junction Box*	JB5DIA	0.21	40.00	6.63	2.42										
JB#6 6' DIA	Junction Box*	JB6DIA	0.25	40.00	6.67	2.42										
JB#6 7' DIA	Junction Box*	JB7DIA	0.29	40.00	7.05	2.76	7.59	2.80	2.84	8.13	2.84	8.67	2.88	9.22	2.93	9.76
JB#6 8' DIA	Junction Box*	JB8DIA	0.33	40.00	7.08	2.75	7.63	2.80	2.84	8.17	2.84	8.71	2.88	9.25	2.92	9.79
JB#6 9' DIA	Junction Box*	JB9DIA	0.38	40.00	7.13	2.75	7.67	2.79	2.83	8.21	2.83	8.75	2.87	9.29	2.91	9.83
JB#6 10' DIA	Junction Box*	JB10DIA	0.42	40.00	7.17	2.75	7.71	2.79	2.83	8.25	2.83	8.79	2.87	9.33	2.91	9.88
Stub	Stub into Culvert	STUB	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

\* Maximum Depth for use in Geopak equals tabulated depth (to top of structure) + Minimum Depth based on pipe size.

Add an additional 2 feet for minimum cover over structure to Minimum Depth of Cover if junction box is within the clear zone.

Type: Outlet																	
Endwall	Endwall for outlet pipe(generic)	EW	0.00	Pipe Size*	4.00	0.00	4.50	0.00	5.00	0.00	5.50	0.00	6.00	0.00	6.50	0.00	0.00
Outlet Stub	Stub into existing structure	STUB	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ditch Outlet	Special ditch end	STUB	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

\* During initial design, set the Maximum Depth to a value greater than the expected pipe size and the Minimum Depth of Cover to 0.00. Once pipe size is determined, reset the Maximum Depth to the designed pipe size + the distance to the top lip of the endwall to be used with the pipe and reset the Minimum Depth of Cover to the distance to the top lip of the endwall.

**Table B Pipe Sizes 48" - 78"**

Drainage Node Name	Node Description	Cell Name	Drop Across Bottom of Structure	Max. Depth	Pipe Sizes											
					48			54			60			66		
					Min. Depth	Min. Depth of Cover	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth of Cover	Min. Depth	Min. Depth of Cover	Min. Depth of Cover
Type: Other																
EW Inlet	Endwall Inlet into drainage system	EW	0.00	Pipe Size*	4.00	0.00	4.50	0.00	5.00	0.00	5.50	0.00	6.00	0.00	6.50	0.00
Ditch Begin	Begin special ditch	STUB	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ditch Change	Special ditch shape change	STUB	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

\* During initial design, set the Maximum Depth to a value greater than the expected pipe size and the Minimum Depth of Cover to 0.00. Once pipe size is determined, reset the Maximum Depth to the designed pipe size + the distance to the top lip of the endwall to be used with the pipe and reset the Minimum Depth of Cover to the distance to the top lip of the endwall.

Type: Headwall																
Culvert Endwall	Pipe Culvert Endwall(generic)	EW	0.00	none	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

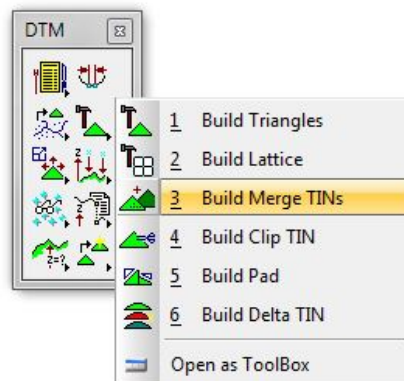
Type: Grate - Bridge Drains																
BD 2'X8'7"	Bridge End Drain	BD2X8	0.00	3.50												
BD 4'X8'7"	Bridge End Drain	BD4X8	0.00	3.50												
BD 2'X9"	Bridge Deck Drain	BD9X2	0.00	1.50												

Type: Curb - Bridge Drains																
BD-PRPT	Bridge Deck Drain - Parapet	BDPRPT	0.00	none												

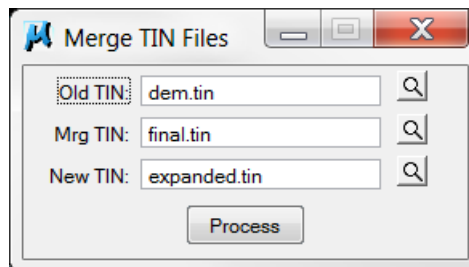
## Completing Drainage Areas

This exercise shows options for the user to calculate drainage areas not included in the survey TIN file.

- Step 1.** Create a TIN Surface for areas outside the Survey TIN. Follow the processes outlined in the [Creating Geopak TIN Surfaces from USGS DEM Data](#) document available from the Roadway Design Division – CADD Standards and Downloads website.
- Step 2.** Merge the project Final TIN with the TIN surface created in Step 1.
  - a. Open DTM Tools by clicking **Applications> GEOPAK> Road> DTM Tools**.
  - b. Within the DTM Tools dialog select **Build Merge TINs**.



- c. Set **Old TIN:** to the TIN File created in Step 1. Set **Mrg TIN:** to the Final Project TIN file. Create a unique name for the **New TIN:** file.

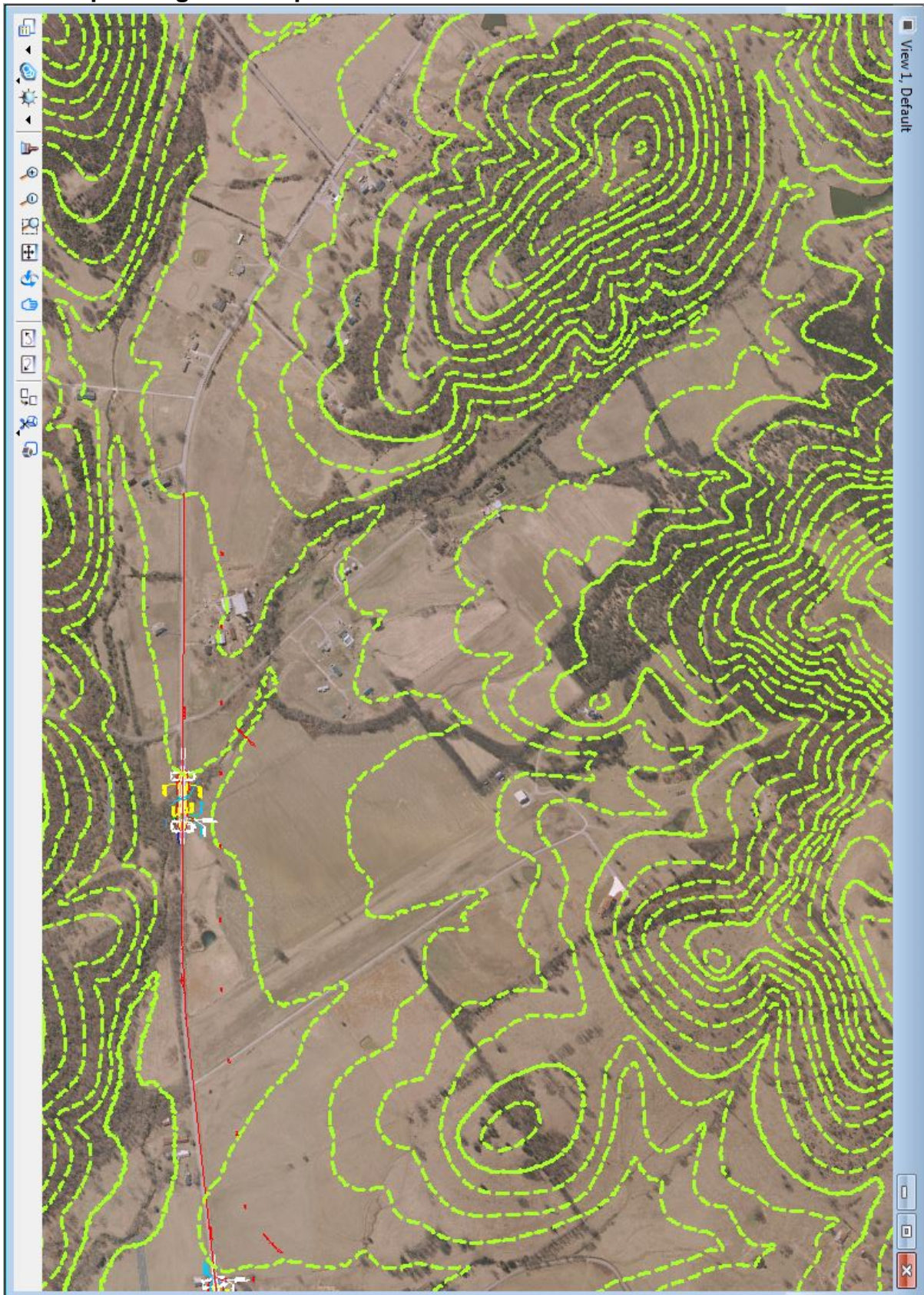


- d. Click **Process**.

- Step 3.** Visualize contours for the New Merged TIN utilizing steps from the [TDOT GEOPAK Road Course Guide](#), Exercise 22b.
- Step 4.** Use this process with DTM tools presented in this document in conjunction with MrSID images or other aerial photography to determine approximate flow paths and drainage areas.

**NOTE:** MrSID images can be attached by following the process in the [Using MrSID Image Files in MicroStation](#) document.

Example image with expanded surface information:





# Common Network Errors and Fixes

This information shows common network errors experienced and possible solutions to correct them.

**Error:**

Link SS- # velocity less than minimum desired.

**Solutions:**

Increase the slope of the pipe/ditch.

Decrease the size of the pipe/ditch (if possible) (Smaller flow area means higher velocity).

Change the type of pipe/ditch (if possible) (Smoother pipes typically have higher velocities).

**Error:**

Link SS - # velocity greater than maximum desired.

**Solutions:**

Decrease the slope of the pipe/ditch.

Increase the size of the pipe/ditch (if possible) (Larger flow areas means lower velocity).

Change the type of pipe/ditch (if possible) (Rougher pipes typically have lower velocities).

**Error:**

Capacity for Inlet CB - # Exceeded Bypass Flow Unassigned.

**Solutions:**

Assign a downstream node to accept the bypass.

Use double or other multi-grate catch basin or drop inlet.

Add additional upstream catch basin(s) to ensure all runoff is captured within the system.

If none of the above are feasible/practical, ensure the bypass flow has a place to flow into another storm drain system or roadside ditch and the error can be ignored.

**Error:**

Computed Ponded Width for Inlet CB - # Exceeds Maximum.

**Solutions:**

Move closer to upstream catch basin.

Add additional catch basin upstream.

**Error:**

HGL Blowout upstream of Link SS - # minimum freeboard not achieved

**Solutions:**

For Storm Sewers:	Increase pipe size. Increase pipe slope.
For Ditches:	The top of node should be above the Hydraulic Grade Line (HGL). Confirm the HGL is below the soffit and ignore error.

**Error:**

Min/Max Depth Exceeded at Upstream/Downstream of Link SS- #.

**Solutions:**

For Storm Sewers:	Check held elevations and slopes in the <i>Link Configurations Conditions</i> dialog.
For Ditches:	Confirm node/link elevations are correct and ignore error.

**Error:**

Profile Warning for Link SS - #:  
→Minimum Slope used for Positive Drainage  
→Check Held Elevations and Slopes

**Solutions:**

Check held elevations and slopes in the *Link Configurations Conditions* dialog. Make changes as necessary.

**Error:**

Soffit elevation adjusted for ditches:

**Solutions:**

No correction required, normal adjustment required when ditch inverts are held at specific elevations.

**Error:**

Catch Basin Minimum Depth exceeded on most catch basins, depth gets progressively deeper from beginning of network to end.

**Solutions:**

Check Link preferences, turn off rounding of link slopes if on.